THE

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THE ECONOMICAL SUPPLY OF POWER.

MR. ALEXANDER SIEMENS gave an address to the Liverpool Chamber of Commerce on Tuesday last week on "The Economical Supply of Power." The object of the meeting was to hear from Mr. Siemens and those who accompanied him, among whom were Mr. Percy Sellon, Mr. Dixon Davies, and Mr. H. G. Harris, the prospects of securing a supply of cheap and effective power from the centralised electricity supply schemes for Lancashire and elsewhere, in respect of which Bills are now before Parliament. The meeting, which was largely attended, was composed essentially of hard-headed business men, thoroughly representative of the most intelligent section of the thinking public; hence their reception of the evidence submitted to them is invested with something more of significance than the opinions of those green in judgment, or stiff in self-seeking opinion.

Mr. Siemens pointed out that the march of civilisation is measurable by its steps in the path of the gradual substitution of mechanical power for manual labour, and pleaded that facilities to this end should be afforded, not merely in the interests of progress, but of the national welfare of this country. In the struggle between the peoples of the earth for commercial and industrial supremacy which our times are witness to, the battle, he argued, will be to those who are strong in cheap power rather than in cheap labour.

We do not know how far it is generally realised that these power distribution projects before Parliament, of which there are some half-a-dozen, cover an area of something approaching 10,000 square miles, and embrace the busiest industrial districts of Lancashire, Cheshire, Warwickshire, Leicestershire and Nottinghamshire. Under these vast schemes it is intended to supply power at a price which none but the largest of our existing central stations have as yet dreamed of.

To these schemes there are two classes of objectors:—the technical critics and municipalities. The former contend that these undertakings can't succeed; the latter that they shan't—if they can prevent it. The distinction between these attitudes is an important one from the point of view of public advantage, which, as we have consistently maintained, is the predominant interest in all such questions.

When the technical critic throws the search-light of inquiry on to the technical and commercial problems involved in these bold projects he advances at once the cause of science and industry, and renders the public and the country alike valuable service. But can the same be fairly said of the *rôle* assumed by the municipalities?

Dismissing the frenzied clamour of the irresponsible municipalist, whose criticism of such schemes is based chiefly on the ground that they are the work of the "rapacious capitalist" (as though the desire to embark on profitable enterprise were a thing reprehensible in itself), we come to the stand taken by the more sober local politicians of the great cities such as Manchester, Liverpool, and Sheffield. Resolutions recently passed by the Councils of

these and other leading towns embrace the following propositions:—

(*a*) The grant of powers to private enterprise to distribute electricity over several local areas from one centre is opposed to the principles of local self-government.

(*b*) A local authority should be permitted to serve areas outside its own by arrangement.

(*c*) If powers are, or have been, granted to private enterprise, a local authority should not be debarred from entering into competition by at any time subsequently establishing its own undertaking.

(*d*) Where a local authority has established its own undertaking, private enterprise should not be allowed to come in and enter into competition with it.

It will be observed that there is some approach, if not to paradox, at least to anomaly, among these views. That they are not shared by all is evidenced by the fact that at a recent meeting of 47 Urban District Councils called at Manchester to consider the Lancashire power schemes, 15 of them declined to support the remainder, holding that the undertakings are likely to prove beneficial to their populations. This view is also the prevailing one among the Chambers of Commerce in the areas affected; for we observe that they are coming forward in support of the principles underlying the Bills.

These facts, and the differences of view existing among local authorities themselves, of some of which we have given examples, bring us again to strongly advocate the course suggested in our recent issues; namely, the appointment of a Joint Committee of Parliament or Royal Commission to consider and define, in the interests of the public and of trade, the sphere and scope of municipal enterprise, and its relation to the industrial interests of the country. "Where no counsel is, the people fall," said one who had reason to speak with knowledge of domestic confusion, and lived to suffer its consequences. We may fairly ask to be delivered from illustrating in our time and place the unpleasant truth that history tends to repeat itself.

American Technical Education.

From a paper recently read before the American Institute of Electrical Engineers, it appears that the same difficulties are experienced there as here in respect of the lack of good workmen. There are a large number of foreign workmen in American shops, and the great development of piece work has rendered most shops unwilling to admit apprentices, and the American youth is almost compelled to fall back upon some sort of school. Possibly the evil has been more felt in America, because with so many trained workers from Europe constantly offering their services, Americans have not realised the necessity of training the young. The paper states that electrical workmen, such as wirers, have been required in a short time to change from cleats and mouldings to iron pipe and conduit, and have acquired such efficiency as they possess at the expense of their employers' material. Only occasionally do exceptionally skilled men turn up and engender the wish for more of them. The facilities for education in America are pronounced unequalled except in the line of the actual trade school, and parents are blamed for selecting colleges and universities without a thought to the compensation their children will acquire in later life when by sending them to a trade school they could, at least, acquire such skill as would secure them permanent employment at good pay, with prospects of advancement to higher posts in place of genteel poverty which training in more refined circles has bound him to. Here we see the tacit acknowledgment in republican America that the manual worker is necessarily unrefined. What is wrong is that the manual worker is so often so coarse and unrefined. It is so in America and it is so in England. More or less dirty work has its effect on all but the most robust characters, and ends in total neglect of the amenities of life. There are some shops where baths and other facilities are afforded, and, we believe, there would be more such if employers believed they would be used, or workers asked strenuously for them. The author of the paper referred to mentions three trade schools in America, and remarks on the indifference to them of the employers who ought to help on such excellent schools, and their persecution by the working fraternity, which he contrasts with the different attitude of lawyers or physicians to the schools in their professions. A trade school in New York is the Auchmuty School, which has now an electrical course, and has been helped by Mr. J. Pierpont Morgan and others. For the training of workmen we are very much inclined to think that the teaching should be entirely practical, or with a minimum of scientific work or theory, unless as a special course. But we would allow the practical course to be purely so. We would teach a trade and leave to those who desired it the option of acquiring higher knowledge in other classes, which should not be compulsory. There are boys, sons of workmen, who have no ambition to be other than manual workers—let them be well taught to be what they desire. It is, we believe, a lamentable fact that the facilities for apprenticing the boys of poor parents, are so few that boys have been tempted to do something leading them to be sent to industrial schools where they are taught a trade. It does not seem fair that criminal boys should be given a better start in life than honest boys, yet this is how the matter is looked on. From all round we hear complaints of the British workman, and of his dirty, dissolute and idle ways and loafing practices. A good trade school would do much towards the acquisition of habits of cleanliness, and in the present state of affairs it would enable a boy to become what in older times he was expected to become in his seven years' apprenticeship. A seven years' apprenticeship may not be necessary to make a boy into a brass finisher or a lathe hand, or even the more highly endowed pattern maker, but the old time apprenticeship involved working with an old time millwright and turned out such men as Rennie and Fairbairn, men of resource who, if they existed now, would not be able to acquire the same experience as they did in their day. We repeat, trade schools should stick to trade. Students could acquire so-called book knowledge by reading. It would be a matter for the employment of their spare time.

The Utilisation of Blast Furnace Gas.

In considering this question the *Engineer* is inclined to throw a good deal of cold water upon this most obvious economy. The utilisation of waste products is one of the directions of modern scientific work, and it is a direction always more or less discouraged. Recovery of sulphur from chemical waste, and of the ammonia and tar from blast furnaces and coke ovens are examples of this. Our contemporary appears to be worried over the use of the new power in producing blast, for the breakdown of a gas engine would have such serious results. The immediate future by no means calls for this use. When all furnaces have their power plant, it will be a small matter to drive the blast of one furnace temporarily by means of electric current from the nearest neighbour. A furnace can then be blown in again with other power. Further, in many furnaces the blowing engine, even if gas driven, could always be worked to get up the furnace to a gas producing stage by means of gas from the nearest town main. There should be so great a demand for current that for a long time to come there will be a sale for the gas without unduly pushing it to produce blast, in any case where this is undesirable. But gas engines are becoming more and more reliable every day, and there are appliances already made with gas engines which enable them to be temporarily and quickly converted into oil engines. A blowing engine for using gas could be worked by oil until the gas began to come over of proper quality and quantity. Engines of 200 and 250 H.P. are now at work with the gas from blast furnaces, so that the experimental stage has gone by.

ON OSCILLATORY AND ROTATORY MAGNETIC FIELDS, AND THE THEORY OF THE SINGLE-PHASE MOTOR.

By MICHAEL B. FIELD.

(*Continued from page* 196.)

We will now apply the principle of substituting two rotatory fields, for one oscillatory, to the case of various alternate current motors.

The Single-Phase Synchronous Motor.—Consider a revolving field type of motor. The armature is supplied with an alternating current, the effect of which is to produce an oscillating field of the same number of poles as the field magnet. This corresponds to two rotatory fields, one travelling forwards and one backwards. If, then, the field magnet be rotating, say, forwards, with the velocity of the forward component field, there will be no relative rotation of the two, and a more or less steady force will be exerted in the poles of the field magnet. The backward component of the armature field will exert no resultant torque upon the field magnet, as the frequencies of the two do not correspond.

Induction Motor running at Half Synchronous Speed.—It has been found that if one of the slip ring brushes of a Y wound rotor placed in a rotating field be raised so that only two phases are operative, the rotor may run with stability at about half the speed of the rotating field. The explanation of this is as follows:—If the field be rotating at n_1 revolutions per second, and the rotor at n_2 revolutions, the frequency of the current in the operating phases will be $\frac{p}{2}(n_1 - n_2)$, where p = number of poles of the motor. This current will give rise to an oscillating field, or, say, two rotatory ones, the one revolving forwards and the other backwards relatively to the rotor with a speed of $(n_1 - n_2)$ revolutions per second. The absolute velocities of these rotating components or the velocities relatively to the stator will be clearly $n_2 \pm (n_1 - n_2)$ or n_1 forwards, and $2\,n_2 - n_1$ backwards. The forwardly rotating component therefore keeps in step with the revolving field, and it is by the mutual attraction between these two that energy is imparted to the rotor. The backward rotating component revolving as it does with a velocity of $(2\,n_2 - n_1)$ relatively to the stator acts as a generator supplying power to the supply circuit, and consequently forces are exerted which tend to oppose its rotation. If, however, $2\,n_2 = n_1$ the backward component is at rest relatively to the stator and does no work on the supply circuit. If $2\,n_2 < n_1$ the backward component is travelling backwards relatively to the stator and the force exerted will tend to hurry on the rotor. If $2\,n_2 > n_1$, the backward component, will have a forward rotation relatively to the stator and consequently a retarding force will act upon the rotor. At the speed $\frac{n_1}{2}$ there will be therefore a niche in the torque speed curve which will, under certain conditions, represent a point of stability.*

The Rotatory Field Produced by a Two-Phase Current.—If we supply two coils whose axes are at 90° to one another with two equal alternating currents with a ¼-phase difference between them we get, as everybody knows, a rotatory magnetic field.

This fact is self-evident, but we give it as another instance of the decomposition of an oscillating field into two component rotating ones.

Representing the oscillating field of phase, A, by the two rotatory vectors, A_F A_B, to the right hand of fig. 3, and the field of phase, B, by the vectors, B_F B_B, to the left hand, and remembering that the vectors, B_F B_B, are 90° in advance of A_F B_B, we may imagine the two sets superimposed, and we see that B_B counterbalances A_B, and we have as a resultant the rotating vector $A_F + B_F = 2\,A_F = 2\,B_F$. Similarly with a three-phase system the resultant rotating field is equal to 1·5 times any one of the three oscillating fields.

* Since the completion of this portion of the paper an article written by Mr. Hermann Cahen, of Frankfort, has appeared in the *Electrotechnishe Zeitschrift*, December 8th, 1898, entitled, "Ueber Drehstrom-motoren mit einphasiger Ankerwicklung," in which this subject is dealt with very fully, and in a very similar way.

A little investigation will also lead to the result that if we compound two equal oscillating field distributions whose axes are at right angles to one another, and which differ by the angle $\frac{\pi}{2}$ in their phase relation, or three equal oscillatory fields whose axes make 120° with one another, and whose phase relations differ by the angle $\frac{2\,\pi}{3}$, which field distributions though oscillatory are not sinusoidal, we obtain as a resultant a pure rotating fundamental field (or rotating sinusoidal distribution), together with a series of harmonic fields, of which the numbers of poles are direct multiples of the number of poles of the fundamental distribution, and

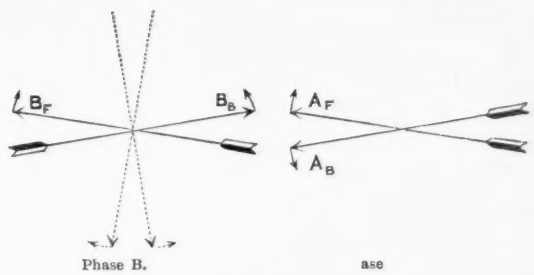


Fig. 3.

whose velocities of rotation are corresponding sub-multiples of the fundamental speed of rotation. Thus it is that even with two-phase and three-phase windings harmonic fields probably exist which, under certain circumstances, give rise to the tendency of the rotor to drop into stable running at speeds corresponding to sub-multiples of the true synchronous speed.

The general principle by which rotational energy is imparted to the rotor of an induction motor when placed in a revolving magnetic field is as follows: Let n_1 be the speed of rotation of the field, and let n_2 be the speed of the rotor. There being relative motion or slip between the rotor and the field, currents will be induced in the former of a frequency corresponding to the slip $(n_1 - n_2)$. The combination of these currents is a wave which travels forward relative to the rotor at a speed of $(n_1 - n_2)$ revs. per second, and therefore keeps in step with the field, and it is in virtue of the mechanical force exerted by the field on this current wave that a torque is imparted to the rotor. Let us denote the value of this torque by T; the power developed by the rotor will be T n_2, whereas that imparted to the rotor by the revolving field is T n_1; the difference, T $(n_1 - n_2)$ representing the lost power in the rotor bars or the C^2 R expenditure.

We thus see that the torque which the rotor develops in a given field at a given slip can be determined by dividing the C^2 R loss by the slip.

Now the rotor currents, as has already been explained, tend to produce a field of their own. They cannot, however, give rise to any magnetic lines which thread through the stator windings for these are overcome by the superior magnetising force of the stator current. They do, however, give rise to a leakage field, that is, they produce lines forming closed circuits round the rotor bars, without threading the stator windings. These leakage lines reach their maximum value when the current is a maximum, and consequently produce an E.M.F. in the rotor bars in quadrature with the current in them. In the same way the magnetic lines called into existence by the stator current which close themselves around the stator windings without enclosing the rotor bars are leakage lines and produce an E.M.F. in the stator windings in quadrature with the current in them.

The effect produced by the leakage lines of the rotor is very important, for it largely determines the breaking down point of the same when placed in a given rotating magnetic field. Let us denote by L the maximum of the E.M.F. wave generated in the rotor bars by the leakage field produced by a wave of current such that the maximum current per rotor bar is one ampere, sweeping round relatively to the rotor with a frequency of one cycle per second. We have then the effective value of the rotor currents when the rotor is revolving relatively to a given field, as proportional to

$$\frac{(n_1 - n_2)}{\sqrt{R^2 + L^2 (n_1 - n_2)^2}},$$

where R is the ohmic resistance of each rotor bar, and the torque will be proportional to

$$\frac{n_1 - n_2}{R^2 + L^2 (n_1 - n_2)^2},$$

but this expression reaches its maximum value when $n_1 - n_2 = \frac{R}{L}$.

Consequently, if we determine experimentally the speed at which the rotor breaks down when placed in field of constant strength, rotating with a known velocity, we have at once a method for the determination of the constant, L. This matter will be referred to again and discussed more fully later on in the course of this paper.

The Single-Phase Motor.—We will now investigate the case of a single-phase motor, of which the stator is completely and uniformly wound, and of which the rotor is built on the squirrel cage plan. The main points we must keep in mind are :—

(*a*) The resultant field (F) actually existing in the air gap, it being due to and maintained by the resultant of the rotor and stator magnetising forces.

(*b*) The distribution of stator currents (C_F) necessary to maintain (*a*).

(*c*) The distribution of rotor currents (C_R) produced by the rotation of the resultant field, F.

(*d*) The distribution of stator currents (C_S) necessary to exactly counterbalance the magnetic effect of C_R.

(*e*) The sum of C_S and C_F, or the actual stator current distribution that must exist in order to maintain F in spite of the counter-magnetising forces of the rotor. In other words, the current which flows into the stator must first overcome the magnetic effect of the rotor currents and over and above that be sufficient to maintain the field, F. It is, of course, this field, F, which produces the counter E.M.F. in the stator, and the E.M.F. in the rotor to which the rotor currents are due.

Lastly, we must not lose sight of the fact that with the single-phase motor the distribution of currents in the stator winding is purely a pulsating distribution, and in no sense equivalent to a rotating current wave.

We will start by assuming a bipolar sinusoidal field, F, rotating relatively to the rotor and stator, and determine, as mentioned above, the rotor's currents, C_R, the balancing stator current, C_S, the stator magnetising current, C_F, and hence total stator current. Now, this may seem to be beginning at the wrong end, but it is not so very unreasonable, for we have seen that whatever field distribution we may have, we may say it virtually consists of a number of rotating sinusoidal distributions, all of which may be treated in the same way, and thus it is that by suitably superimposing various harmonic components upon one another, we can approximate to the conditions which actually obtain.

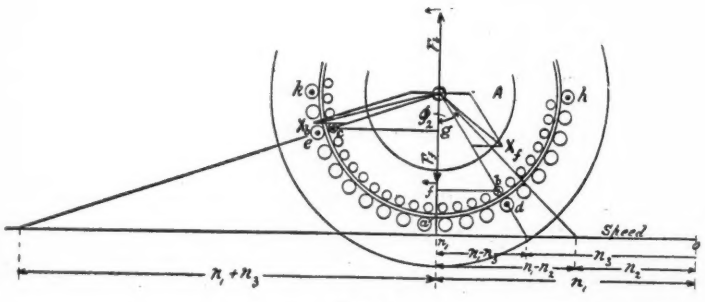


Fig. 4.

Referring to fig. 4, we will represent speed along a horizontal axis, and draw a vertical line through that point which represents the speed of synchronism, (n_1). Suppose it to have been experimentally determined that the rotor which we are going to consider develops its maximum torque when rotating with a slip of ($n_1 - n_2$) revolutions per second relatively to a field of constant strength in which it is placed. From the point on the horizontal axis representing the speed, n_2, draw a line at 45° to cut the vertical axis through n_1 in the point O.

Consider the point O to represent the centre of the rotor, and with this point as centre draw in to any scale whatever a few circles to indicate roughly the rotor and stator themselves. Let us assume that in the air-gap thus depicted we have two equal bipolar sinusoidal field distributions, one revolving forwards (F_f) and the other backwards (F_b), each at a speed of n_1 revolutions per second ; and let the maximum induction along the polar diameter of each be B.

At the instant we have depicted in the diagram let us assume that the polar diameter of each of the two field distributions is covering the vertical axis O n_1, but that the induction at *a* due to F_f is directed radially outwards, and that due to F_b radially inwards.

Take the rotor to be revolving relatively to the stator at the speed n_3, and join the corresponding point on the speed axis with the centre O. Now, since n_2 is the breaking down point, or that at which $\frac{R}{L(n_1 - n_2)}$ becomes equal to unity, and the diagram has been so constructed that $\tan \phi_2 = 1$, the length, O n_1, must represent to the same scale as the speeds are shown, the ratio $\frac{R}{L}$.

(*To be continued.*)

ACCUMULATORS FOR ELECTRIC AUTOMOBILES OF THE SOCIÉTÉ ANONYME POUR LE TRAVAIL ELECTRIQUE DES MÉTAUX.

The storage battery constructed by the above company, which is associated with the name of M. Laurent Cély, and with the chloride accumulator, has been specially devised with reference to the requirements of the electric cab. The aim of the company has been to obtain within a comparatively small weight a capacity sufficient for the purpose in view ; whilst producing, at the same time, plates—and more especially positive plates—of sufficient solidity to ensure a certain degree of durability and to render possible the maintenance of the battery under the given conditions, in spite of the high and varying rates of discharge and the mechanical shocks to which traction batteries have to be subjected.

It is not, therefore, an extremely light accumulator that they have had in view, but one adapted for practical use in electric traction.

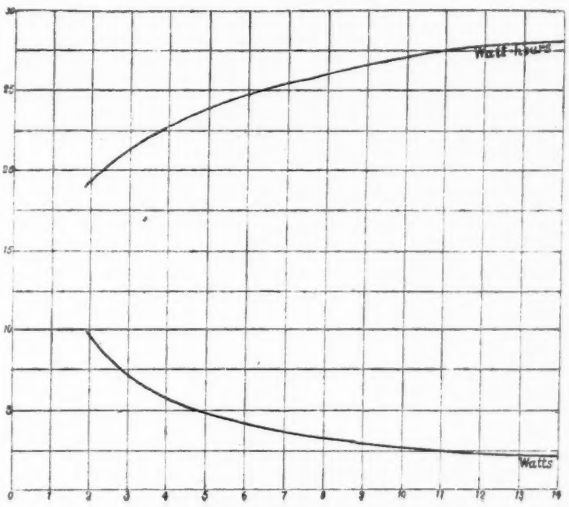
The negative plates of these batteries are of a type derived from that of Faure. Like all those manufactured by the company, they consist of a lead grid acting as a conductor, and as a support for spongy lead obtained by the reduction of lead chloride fused and cast in the form of pastilles. The dimensions of the active material and of the support are adjusted so as to obtain a very high specific capacity.

The positive electrodes, on the other hand, are of the Planté type. They are formed of milled or grooved strips of lead, superposed, and connected together by special means. The form of these strips in section was arrived at by long comparative trials, with the object of obtaining a greatly extended surface and a very ready circulation of the electrolyte, and of avoiding undue deformation during the gradual peroxidation of the metal of which the strips are composed. The special devices adopted have, moreover, the advantage of conferring upon the plates, during the whole period they remain in use, a remarkable degree of constancy and a very high rate of discharge.

It is stated by the company that the energy capacity of the cells constructed with these plates, is, per kilo of electrodes, as follows :—

Rate of discharge.	Corresponding specific energy.
2 watts	28 watt-hours.
3 „	26·5 „
4 „	25 „
6 „	22·5 „
8 „	20·5 „
10 „	19 „

The following diagram exhibits the two curves of power and corresponding energy:—



Cells of this description are at the present time in use for electric hackney carriages belonging to an important conveyance company. They are composed of an ebonite receptacle containing 13 plates, 7 negative and 6 positive, 4·4 inches broad by 8·4 inches in height. These plates rest on a suitable ebonite tapit, and are separated by corrugated and perforated sheets also of ebonite.

The lugs of the plates constituting each electrode are connected by soldering to an omnibus bar of lead carrying vertical rods which traverse the lid of the receptacle, and to which are soldered the connections from cell to cell.

TABLE I.—DIMENSIONS AND WEIGHT OF THE ELEMENTS.

Number	of negative plates	7
	of positive plates	6
Receptacle	length, external	6·8 ins.
	width, „	5 „
	height, „	11 „
Plates	width	4·4 „
	height	8·4 „
	area, both sides	72 sq. in.
	total positive surface in cell	3 sq. ft.
Weight	six positive plates	18·5 lbs.
	seven negative plates (including end plates)	7·9 „
	plates in one cell	26·5 „
	plates, receptacle electrolyte and connections	37·5 „
	total of 44 cells	15 cwt.

These connections are formed of flexible conductors having a core of stranded tinned copper wire, which is enclosed in a lead tube with a perforated knob at each end. Two of these conductors are used to connect up each set of plates.

The dimensions and weights of the plates and elements are given in Table I.

The specific (?) energy, when the rate of discharge of the cell is 70 watts, is 250 watt-hours; and the weight of the cell is 37·5 lbs., including the electrolyte and the two-fold connections. Various data relative to this rate of discharge are given in Table II.

TABLE II.—RATE OF DISCHARGE, POWER, CAPACITY, &C.

Duration of discharge		3·5 hours.
Normal rate of discharge (amperes)	per square inch of active positive surface	·0837
	per positive plate	6·1
	„ lb. of cell	1
	„ cell	37·7
Electromotive force per element.	Volt.	1·9
Normal power (watts)	per lb. of plate	2·65
	„ „ cell	1·86
	„ cell	70
Specific energy (watt-hours)	per lb. of plate	5
	„ „ cell	3·53
	„ cell	132
	„ 44 cells	11,000
Energy in H.P.-hours per 44 cells		15
*Weight per kilowatt (lb.)	plates	376
	cell	532
*Weight per kw.-hour (lb.)	plates	10·5·5
	cell	150
Weight per H.P.-hour (lb.)	plates	77·6
	cell	110

* In the article by M. Reyval in *l'Eclairage Electrique* for December 31st, 1898, the values here given for the weight per kilowatt and per kilowatt-hour are transposed. The weight per kilowatt is necessarily greater than the weight per kilowatt-hour when time of discharge is specified, and when it is greater than unity.—EDS. ELEC. REV.

The company also manufacture for electric traction, batteries having a higher specific capacity, but in which the durability of the positive plates is not so great as that of the Planté type plates, although the former will withstand without injury 100 charges and discharges. In these cells the positive electrode is composed of plates manufactured in a similar manner to the negative plates. Their specific capacity for discharges of five hours and under is at least 30 per cent. greater than that of the cells with Planté plates. They may be usefully employed in cases where the cost of maintenance of the battery is of less moment than lightness and high specific capacity.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE paper taken at the last meeting of the Institution of Electrical Engineers, held at the Institution of Civil Engineers on Thursday, 9th inst., was on "Electric Traction by Surface Contacts," by Mr. Miles-Walker.

In opening the discussion thereon, Prof. Carus-Wilson congratulated the author on the successful issue of the experiments, and the ingenious application. The problem was a very important and difficult one. He hesitated to express an opinion on the apparatus, at present, to a certain extent, in an experimental stage. The author wished to get the criticism of the Institution; he therefore thought some points not made much of might be mentioned, as they were characteristics of the system. In some systems a leakage current was liable to make the studs alive; in this case it was apparent that leakage could not do so, and the author was to be congratulated on this feature. As regarded safety, he could not conceive a more safe method than the mechanical magnet contrivance. The author has shown it was impossible for it to remain up when the car was away; but other elements had to be dealt with. It was possible to sacrifice too much to safety; accessibility and reliability have also to be considered. Any electro-magnet should be easily got at without interfering with traffic. A serious element was the opening of any such things while the traffic was running. Two minutes per stud mounted up. He thought it should be more accessible for repairs. The point against the system was that repairs could only be done while traffic was off. As regarded reliability, ice was the only apparent thing that would interfere with the working of the system. Coming to mercury contacts, he was sorry the author had dispensed with mercury; he did not believe in the prejudice against mercury contacts. As regarded sparking, the success of any system of surface contacts depended upon absolutely doing away with sparking at contacts. Some further remarks offered on this point were, we believe, made under a slight misunderstanding of the working of the switch.

Mr. S. Sharp, from experience with tramways, thought this type was the best yet seen. He regarded Prof. Carus-Wilson's point about breaking the current, unfounded, as the plunger could not fall until skate had quite left stud—the spark must, therefore, take place as the skate moved off. As seen at Willesden, the switch appeared to be easily removed when required, and he thought it was the most easily removable switch yet made,

as it could be loosened in a few seconds by the simple removal of three screws only. The danger with most such systems has been the leaving alive of the studs; here there were no springs to get out of order, the action depended upon a falling weight. Many places could be found where this system could be used in preference to conduit, for instance, in Glasgow, in Argyle Street, the Caledonian Railway came within 10 inches of the top of the road, and this reason was one given in favour of overhead tramways. The system before the meeting slightly modified could have been used.

Prof. Ayrton cited the three methods of traction: the trolley, the sub-divided conductor, and surface contact, *i.e.*, stationary studs made alive. He was interested in the last two, as the Ayrton and Perry patents included this idea 18 years ago. It was too late to make any money out of it, all that could be done was to make it a success. He did not want to take a rosy view or the reverse. Inventors usually took a rosy view of their own work. He was an inventor himself, so he knew. The leakage mentioned in the paper was 4½ amperes, suppose it were 5 amperes—it might be 7 or 8—that is 2½ kilowatts per car to earth; what would the Board of Trade say to that; how about damage to pipes? Then the excess power required at the station for this cause might amount to 40 per cent. of the total output. The London County Council are connected with traction on the South Metropolitan Tramways—why not try this system? The author had made a very generous mention of his work in the British Association paper on the Thompson-Walker system, and the following remarks might appear a little ungenerous. When he read the British Association paper it struck him that the system was not yet perfected as Prof. Thompson gave the world to imagine. Dirt or paper on the studs might break the circuit, and if one car failed to make contact it would block every car on the system, while if the main supply were interrupted for a second the whole of the cars would be stopped. It was now stated that each car carried a 500-volt accumulator to get over one difficulty, but the minor difficulty was introduced that a battery of accumulators was required on each car, so that if the skate failed to make contact the battery picked it up. There were serious difficulties in the mechanical arrangement of the switch. The mercury contacts in the system, supposed to be perfect, are now done away with and several minor alterations made. Why should a system that was so perfect require to be changed? He believed that the other contact box would have failed in actual work: he had yet no time to examine *this* contact box. The leakage of current was certainly serious. He should not like the London County Council to adopt this system, which in the last few months has been so greatly altered and presumably is not yet practical. Prof. Ayrton rose again to inform Prof. Carus-Wilson that ice has been seen in England.

Mr. A. J. Lawson mentioned that at sharp curves the skate might make contact with the rail. The leakage at the rate of ½ ampere per car would, for 40 cars, amount to 10 kilowatts. He would be very glad to supply such a system as this from a central station where the units sent out were paid for. There was a difficulty in finding space for underground constructions, and pipes might have to be removed to make room for the switches. He protested against the sentimental rubbish talked about overhead wires.

Mr. Scott considered the system very pretty, but queried its practical success. At crossings, the leakage through mud might be sufficient to start an arc to rails, and blow fuses. It has been suggested to insulate the parts of rails at crossings, but he did not think it feasible. All previous work had shown that it was necessary to separate the switch and stud, and not have them in the same box. Micanite was used in the switch as insulation, but being subject to blows was not reliable. Hammering on the tops was liable to work loose the various parts. The yoke might stick to coil, causing the fuses to blow. A shunt coil being used, it was necessary that contact should be broken, but experience has shown how difficult it is to break circuit without breakdowns of insulation.

Mr. Couzens Hardy thought that safety was determined by extraordinary conditions, not by ordinary—first, if part of the coil became short circuited it might be out of balance, and the core held up; secondly, the amount of leakage depended on the horse traffic in the road in question. Experiment has shown that 20 to 30 amperes at 500 volts from rail 2 feet away can leak if liquid from stable drain be poured over the contact—this is not an ordinary condition, but one liable to occur at any time. Again, if the falling of the tube were slow, a dray following the car might provide necessary iron to attract the plunger. The wear of studs was another point, difficulties had been found in Paris with studs where brass studs had worn down in six months, if the studs were of iron then the difficulty was to avoid sticking up. The insulation of the rail at turn-outs deserves consideration.

Mr. G. C. Sillar thought that the last speaker had, if anything, under-estimated the probable amount of leakage. The difficulty with skates where obstacles were in the way was considerable. He had found with motors that 2 or 3 inches clear of ground was not always sufficient over bridges and sharp corners. Another point was the side swing of the car at corners; with a curve of 30 feet radius, the studs would have to be 4 feet wide!

Mr. Tremlett Carter raised the point about the removal of studs, which, although occupying only a few seconds, would be quite long enough in wet weather to admit damp, and water would fill the box in very bad weather. The box could, of course, be drained. He looked forward to a practical trial.

Dr. S. P. Thompson, who occupied the chair, stated he left the responsibility of the paper and the reply to Mr. Miles-Walker, but he was amused to listen to all the dreadful things that must happen. He had spent time and money on trying to find out whether all these things would really happen.

Mr. Miles-Walker then replied. He stated that the skate end was turned up, and the iron was sufficient to hold up the core after current is broken, so that the break will always be on the stud. He thought Prof. Ayrton was much before his time. In the paper two minutes were given as the time required to open the switch, but this was an outside figure. A 500-volt accumulator was provided for use on the car, but the switch would work at 100 volts. Accumulators were mentioned in the British Association paper. Mercury contacts had not been abandoned, but they had to give way before popular prejudice, and if the work could be done with a switch it could be done with mercury.

Although slight improvements were seen from time to time, it was wrong to say that the apparatus was still in a temporary stage; it might as well be said that dynamos were not practical because alterations and improvements are still being made. The leakage depended entirely upon the perimeter of live metal, it was 16 inches only for the stud, it was much greater on the rail mentioned. In reply to Mr. Lawson, the author mentioned that the difference between kilowatts generated in station and kilowatts paid for (or units in either case) was usually more than 2 per cent., and he thought that 2 per cent. loss in leakage was small. A wide skate had been tried on curves, but no difficulty had been found. There was a positive stop to prevent skate approaching rail by less than 1 inch, and it did not reach these in practice. An arc would not form through 1 inch of mud. Whether it was better to have the boxes together or separate was a matter still open to discussion. If micanite was not found a satisfactory insulator, granite would be used. Water could not get into the box when closed. The shunt coil was wound on a thick brass bobbin, and the volts per turn could not exceed a given amount, which was calculated for a little over 500 volts. Short-circuited coils could not cause magnet to stick up, nor could dray follow car quick enough to cause trouble. Provision has been made for changing studs if worn. Mud could be brushed away when met from the studs. Thus ended the reply.

It was announced that at the next meeting the paper to be read would be one on "Wireless Telegraphy," by Mr. Marconi.

CORRESPONDENCE.

Electrical Fittings Censorship.

The want of a bureau in order to establish a uniform set of rules for the guidance of electrical contractors and manufacturers on the question of what fittings are suitable and efficient to be used and manufactured has become more pronounced, if only as an antidote to the pernicious system of registration as adopted in at least one of our Northern cities,

and is being carried out in a manner that is offensive to some, annoying to others, and adding extra expense and loss of time to all concerned.

May I ask you to state that since the publication of my last letter, as information to manufacturers interested, that I am led to understand a slight concession is made with regard to a regulation in a list of rules printed for the electrical department of an English municipality. The regulation reads: "Samples must be submitted in duplicate, and *both* become the absolute property of the Corporation." Now I am informed this rule is broken as glibly as it was made, and though duplicate samples must still be submitted, one of the samples will be returned if the value of each be 10s., or above. I ought to state, however, that it is not made quite clear by my informant whether this is an alteration to be generally observed, or simply one of the many private concessions of a capricious individual in the service of this department. This instance of a sudden and, I believe, hitherto unpublished alteration of a regulation, is not by any means an isolated one. I have no need to remind my readers of the prohibition relating to flexible cord which, after the loss of trade and injustice done, that prohibition was withdrawn.

Surely the Institution of Electrical Engineers will not for long permit an urgent need to exist for a simple code of rules that would be uniform for the guidance of English manufacturers of high voltage fittings? Some rules, it is admitted, are necessary; but why leave it to municipal electrical engineers, in their individual offices, to make regulations which they can break at their discretion?

The contractor is absolutely at their mercy, and to cite the following instance is to show that corporation servants, who are in the service of the ratepayers, are allowed to dictate harassing terms:—A contractor registered a switch for a specific installation and expected he would not be required to lose time in submitting a similar switch for another installation on similar conditions, but he found the switch would not be approved on the second installation unless he again sent one to the electricity station. The contractor was compelled to do this, and had to wait the convenience of the Corporation inspector, involving the loss of a considerable amount of time before that individual thought fit to issue a most elaborate certificate for one switch approved. Whether the present discontent will be so aggravated as to become embodied in a formal protest to the Electricity Committee or to the Corporation itself is a question that can hardly remain long in doubt, or whether the validity of such rules will be proved by the refusal of a competent contractor to comply with one or other of the harassing regulations, is another question which would create a deadlock unless another private concession be made that would simply postpone a definite settlement. The present position is likely to become intolerable, but it would be relieved by the formation of a competent bureau for the purpose of deciding the electrical fittings question. It is not to be expected that municipal electrical engineers, many of whom are young men, some having been suddenly lifted into important municipal positions that would, in some instances, have been more appropriately filled by men of maturer age—I repeat, it is not to be expected they should possess those qualities necessary for administrative purposes that are as important as a sound technical knowledge, and much more so when attempts are made to frame rules to be observed by contractors, many of whom are as capable of judging what fittings are suitable and what are not as the engineer himself. In rules for this purpose it is necessary that the spirit of the dictator should be less in evidence than the ultimate object for the attainment of which the rule is framed. I might point out that municipal electrical engineers have still duties exclusively their own, duties that ought to be more faithfully fulfilled in the future than in the past. When they have provided means for the prevention of explosions in the streets; when they never overlook a bad joint in the main cable; when the recent frequent interruptions of electricity supply, causing our shops, public offices, churches, and infirmaries to suffer the inconvenience of being in total darkness, sometimes on critical and dangerous occasions. When they have done their duty in these respects, it will be time enough to issue obnoxious mandates to contractors and manufacturers who are not less anxious for the prevention of accidents, and to ensure that only those fittings suitable to guarantee the safety of property and life shall be manufactured and used as are the municipal electrical engineers themselves.

C. A. Clarke.

[Our correspondent's covert references to Manchester are not quite fair. To our own knowledge the municipal engineer has modified the rules where they appeared to inflict hardship upon contractors.—Eds. Elec. Rev.]

"Railway Block Signalling."

It is no doubt very wicked for the reviewed to dispute the conclusions and statements of the reviewer, but when the review contains misrepresentations, and something else which I will not characterise at present, the author must protest, or allow judgment to go by default. I find in various parts of the last 34 volumes of your paper that you have accorded the privilege of a reply to reviews, and I have to ask for a similar favour at your hands.

Your readers are told that there is little that is new in my book. Very good. The statement is legitimate, and is, in a sense, a measure of your reviewer's knowledge and experience.

With your reviewer's criticism of the literary construction of the book I do not propose to deal. He is, no doubt, a master of style, although the occasional poverty of language, and the indifference to the distinction to be drawn between an object and its uses, exhibited in portions of the review, would seem to negative the idea.

Your reviewer questions the author's accuracy "in, at p. 7, attributing the introduction of the use of electric semaphore signals to the South-Eastern Company in 1851." The author does not make such a statement.

Your readers are warned against accepting the dates given at which it is said *three-wire block* systems were in use through the tunnels between Ambergate and Rowsley, and on the Desford and Bagsworth incline. Will your reviewer please note that the paragraph relating to the former is qualified with "is said . . . ." and that, later, I give some reasons why the claims of most of the earlier systems of signalling, to be considered "block" systems, are not well founded. I have, however, no reason to doubt the accuracy of the information given me, I was not there at the time. The code given for the Desford and Bagsworth incline shows that both bells and needle indicators were in use. Perhaps, as your reviewer is so certain that the Desford and Bagsworth system was not a three-wire system, he will outline the circuit arrangements to agree with the code.

Your reviewer also questions the accuracy of the conclusion I have drawn with reference to the "Line Blocked" indication on the London and North-Western Company's instruments, as introduced in 1853 by Mr. Edwin Clark. Will he kindly let us know what he considers was the object of providing such an indication in the light of the statement that, under normal circumstances, the needles were kept continuously to either "Line Clear" or "Train on Line," as might be requisite on account of the line controlled being free from or occupied by trains? What would the indication resulting from such a disconnection of the circuit convey to the signalman when he knew that provision had been made for it to be given to him—in case of emergency only?

Your reviewer remarks that the cutting of the line wire was not so frequent as to call for a signal purely applicable to such a transaction. It may or may not have been frequent as he says; I do not know. It is, however, certain that emergency signals are never intended to be *frequently* used. They are provided, nevertheless, although they may not be so labelled. In the case under notice "Line Blocked" was shown, as will be seen from the diagram in the book, when no current was passing through the instrument, and it would naturally take up that position when the circuit was intentionally disconnected for the purpose of indicating to the signalman that something out of the normal had taken place. Your reviewer says, further, the indication (he says indicator, but it does not matter) "would be a proper one for the purpose of telling the signalman that the line was not clear. . . ." If by this is meant clear of trains under normal conditions of running, I may remind him that the indication "Train on Line" provided the information required.

Your reviewer does not agree with me that the indication "Train on Line" as *now* used is a subsidiary indication. I am, of course, sorry that there should be such a disagree-

ment. We are both entitled to an opinion. I have given reasons for mine. Your reviewer has not.

Passing over the disquisition on the relative meanings of "transient" and "momentary," and the degree in which currents may be regarded as "permanent," I come to the lengthy remarks on disturbances of instruments. Your reviewer says that the effects of earth currents upon instruments are only occasionally such as to affect the block signals. If he was a lineman with single needle instruments under his care, and himself under a superintendent who would have things right and saw that they were so, he would probably learn more than he now knows respecting the trickiness of earths, and it is probable that he would get scant consideration for a suggestion to erect a "return wire."

Your reviewer professes to be ignorant of what is meant by "magnetic storms." Magnetic storms are deviations of greater magnitude than ordinary, from the normal distribution of the earth's magnetic field, and their effects upon S.N. block instruments are distinguishable from those of earth currents by the fact that they persist after the line wire is disconnected. Such occurrences are stated in the book to be rare, and the writer has only had experience of them on two occasions.

Passing over your reviewer's exceptions to the terms I have used, and his substitution of others less applicable, I note that he says permissive block working is now a thing of the past, and that it was a vicious system, and worthy of condemnation only. It will, therefore, be a surprise to your reviewer to be told that its use is extending, and is likely to do, as railways increase their traffic. Permissive working is being now applied to a number of places which have hitherto been worked under systems of bell signalling, and without enforcement of the space limit. Your reviewer might study the instances in which permissive block working are referred to in the book, pp. 279—293, from which he would obtain information of the conditions under which permissive block working is advantageous. The intances there given were, at the time the articles appeared in the *Electrical Engineer*, all recent installations, and each instance is different from the others in the advantages obtained.

Your readers are told that "the text (p. 163) does not appear to accord with the illustration. The latter shows line blocked, and not line clear, for an up train." I have to differ from your reviewer again. The text and the illustration are in perfect agreement. The text in "Diagram, fig. 38, is drawn to show 'Line Clear' for a train ready to proceed from the 'up' station to the 'down' station." Such a train is a "down" train, and not an "up" train, as your reviewer considers.

Your reviewer draws attention to an omission on p. 241 with respect to the driver seeing the staff when accepting the ticket. Although he quotes word perfect, he does not put the same emphasis on different parts of the sentence as is done in the book. The word "only" is in italics, as well as "entrance." He also omits all reference to the subsequent mention of methods for preventing tickets being used when the staff is not at the *entrance*, for the time being considered.

Your readers are also told that the illustration on page 299 appears to be inaccurate. I must again differ with your reviewer. The illustration is perfectly correct. "The positive to line" does not "form" the ON signal; the negative does not "form" the OFF signal, and the absence of current does not "form" the "out of order" signal. Nor am I responsible for the name of the latter indication. As shown on the diagram, "the positive to line forms" the OFF signal; the negative "forms" the "out of order" signal; and the ON signal is shown by the vertical position taken up by the needle when no current is passing. If your reviewer had *read* the book, he would have seen some criticism of this method of repeating signals, and he would also have seen that his remarks on "the chief thing to insure" are anticipated.

Your reviewer does not "concur" in the view that more should be done for the engine driver when the ordinary mechanical signals are obscured by fogs or other causes. I am sorry again. May I quote the Electrical Review of January 1st, 1897, on "Block Signalling;" the week after the conclusion of the articles in the *Electrical Engineer*.

"At the same time there is a period in railway working where a method of conveying to the driver of a train the fact that the signals are against him is necessary. During the winter months fogs frequently prevail to such an extent as to render signals invisible. Detonators have then to be laid on the metals, and the driver, on passing over them, is warned by a loud report that the signal is at danger. The question will arise—Is it not preferable to show the driver, by a signal on his weather-board, that such is the condition of things. . . . ."

"We do not despair of the achievement of this. . . . ."

May I draw your reviewer's attention to the fact that the recent accident to the Brussels train is said to have been due to the driver being unable to see the signals on account of fog.

Your reviewer says that I argue "that the driver is the man who should call out, or order out, the fog men, and that very little consideration will convince one of the impracticability of such a course." I must again differ from your reviewer for the reason that no such foolish argument is used throughout the book. Pages 118-119 are devoted to an examination of the arrangements for providing for signalling by detonators during fogs. It is shown that the mechanical signals are for the *driver's* guidance, and that he "is the most suitable person to say when *he* requires additional means to enable him to obey the signals shown; and considerations such as those just adduced, are alone sufficient to stamp as inadequate any *system of signalling, under exceptional circumstances, that cannot be brought into operation at any time the person requiring it may consider necessary.*" I have underlined the last portion of the sentence for your reviewer's benefit. For systems of signalling, which enable the driver to bring them into use at any time he desires it, I must refer your reviewer to the book.

Your reviewer is doubtful about the utility of an uniform code, and uniform methods of working, because there is no interchange of staff between the various railway companies. If he will give his imagination a gallop, he might think of occasions when interchange of staff would be very desirable. The subject is not one for discussion in your columns, and I will not pursue it further.

Your reveiwer will find on p. 100 some remarks on the use of the telephone as an adjunct for signalling puposes, which do not refer to the combination of the telephone with the block bell, and which, if read carefully, may be suggestive.

Your reviewer reserves the most serious assertions for his last sentence. Your readers are told—

1st. That I have ignored those who have invented or introduced practically all the most useful adjuncts referred to in the book.

2nd. That "although it is only reasonable to assume that some information has been gathered from other works devoted to kindred subjects, the only reference to the authors of such works is that to Mr. Clement E. Stretton."

This is disingenuous, to put it mildly, as no proofs are adduced.

With respect to the first charge, may I ask whether your reviewer has seen the table of contents. It bristles with names, and I have endeavoured in all cases to give credit where it was due, *if I knew it*. That I have omitted to say that the particular form of switch shown for the utilisation of the block bell line wire for telephonic purposes, and possibly some other examples, is in use on the Midland, is hardly justification for so sweeping a statement.

With respect to the second charge, is your reviewer aware that I have referred to Mr. Langdon's "Applications of Electricity to Railway Working" (not the present edition), Mr. Preece's 1863 paper at the Institution of Civil Engineers, Mr. Walker's articles on "Train Signalling in Theory and Practice" from the *English Mechanic*, and Sir W. F. Cooke's "Telegraphic Railways," and that acknowledgment is duly made in these cases as well as Mr. Stretton's? Has he seen the acknowledgment to six other gentlemen or firms in the preface for particulars supplied? What more does your reviewer want? In what parts of the book does he consider that further acknowledgment is necessary?

With reference to Mr. Stretton, I may say that I have no personal acquaintance with that gentleman; indeed, I have never seen him. I asked his permission to use information contributed by him in a letter to the *Electrical Engineer* in November, 1896, and he kindly accorded it, and supplemented the information by more of the same character. He also offered the privilege of making extracts where I pleased

from his book, "Safe Railway Working," but this I did not avail myself of.

I do not possess, and have never seen any of Mr. Stretton's books.

I do not possess, and have never seen Mr. Langdon's latest edition, which your reviewer says is the only other work, besides my own, dealing with the subject. Further, I borrowed the first edition from which the information acknowledged was taken. The present edition had not been issued at the time. Mr. Preece kindly offered his own copy, but I had then obtained the loan already referred to.

I have no other works relating to railway management and working, and have consulted none but those acknowledged.

I have, however, drawn largely, and without explicit acknowledgment, upon a "volume" which has not been published, but which has been under construction, so to speak, for about 28 years; and although the owner is aware of it, he has not, hitherto, resented it. I have also had access to another "volume" of a similar character, but much more valuable, which has been under construction for 40 years, and I have not been asked to acknowledge it more specifically than has been done.

Do I make myself fully understood by your reviewer?

J. Pigg.

The "Other Side" of Nernst's Lamp.

In the public interest and as a protest to the hurry with which this lamp is being "readied" for flotation (*vide Daily Mail* of yesterday), I trust you will give me space to lay before your legion of readers, of which I am a humble unit, some disadvantages anent this lamp of which all practical electricians are aware. Before doing so permit me to point out that the investing public are about to be invited to subscribe to an innovation which assuredly is but in its experimental stage, its complication is proof of this, and which they have had no opportunity of testing, or even seeing, or examining, or proving whether it is practical as an indoor illuminant, or even verifying the assumptive economy claimed for it by those interested, surely these facts conduce to make it a most perilous speculation? And I trust that the article "*Re*" the German patent of this lamp, in your last week's issue has been universally read.

1. Mark what a great disadvantage it is that extraneous heating is required, how inconvenient this will prove in practice no one can tell, and if in its present imperfect state it should be used for indoor lighting.

2. What would result if a burglary took place in a user's house, or any of the household was seized with sudden illness, or a fire occurred, &c.? And we must not forget that these, and many others, are emergencies that call for instantaneous light, *which this lamp is impotent to give.* I would refer readers to the trenchant remarks of the chairman, Mr. A. Siemens, at the lecture given by Mr. Swinburne on the above lamp on the 8th inst., *anent the retrogressive process of heating this lamp before it will light.*

3. The lecturer admitted that the arrangement for the preliminary heating *was expensive*, and might have added that "this mode of ignition was not only a waste of time and anxiety, and that such a complicated process must tend to discount what modicum of utility the lamp may possess."

4. The automatic heater (which is said enables quicker lighting) must be costly to produce seeing the amount of platinum there is in it, *so that it's bound to be costly to the user, but what the public charge of the lamp with, or without, this heater will be no one, not even the lecturer, appears to know.* This fact is not at all encouraging, and here let me point out the chairman's remarks anent this.

5. Surely, Sir, *the risk of fire from a naked and unprotected light* must be perilous? especially in factories where inflammable, or very dry materials, are manufactured, in warehouses, drapery and other industrial stores, theatres, music halls, steamers, &c., and that the fire insurance authorities will have something to say on this serious aspect of the case, goes without saying.

6. If space, and you permitted, I might supplement the defective points of this naked light and the savage mode of ignition, the deteriorating tendency of the oxides used in the make-up of the rod, their insulatory tendency, commercial drawbacks, the lamp's "questionable" utility upon continuous current circuits, the constant exposure of the rod to accidental breakage, heat, dirt, smoke, &c. These facts, taken into account with the evasions of the lecturer, for the nature of which I must again refer to the utterances of the chairman, do not enhance or make out this lamp to be what those particularly interested in it would have us "take on trust." For my part, I look upon it as an unsafe and undesirable agent of the current; further, Sir, is it not a fact that what progress has been made in glow lamps is due to the fact that the filament is enclosed in a sealed globe, thus protecting the filament, and obviating the risk of fire, heat, dirt, smoke, &c., and making it safe to use anywhere? and are they not more desirable in "a public service sense," seeing they can be turned on instantly and without the complicated aids of costly automatic heaters, spirit lamps, or tapers?

Pessimist.

The Wehnelt Electrolytic Current Interruptor.

Referring to the interesting account of the above in your issue for the 17th inst., may I say that we have made one of these appliances from your description, and have tried it on a 10-inch Apps coil in this laboratory. It gives the most surprising and beautiful results, and seems to be a scientific discovery of great value, which may have many and important practical applications.

A. A. C. Swinton.

66, Victoria Street, S.W.,
February 21st, 1899.

Kilduchevesky Mega-Telephone Transmitter.

In your current issue you state, under the above heading, that Mr. A. R. Bennett tested the transmitter, and found that "conversation of any description could be carried on without effort" through an "artificial cable equivalent to about 200 miles, and having a resistance of 594·48 ohms, a capacity of 59·73 microfarads, and a K R of 35,508."

Permit me to say that the statement is absolutely untrue.

With regard to your leading article, in which you advocate pitting one telephonic instrument against another in order to "determine which is the *best of the two*" (*sic*), and deprecate the use of artificial cables for telephone testing because of inductive reaction between resistance bobbins; one is constrained to wonder how it comes about that the Editors of the Electrical Review have never heard (as would appear) of an artificial cable in which the resistance is distributed otherwise than by bobbins of wire.

A. R. Bennett.

[In the manuscript which was forwarded to us giving a description of the instrument in question, the exact wording is as follows:—

"The Kilduchevesky transmitter was successfully tested in Russia on overhead lines, distance being up to two thousand miles (2,000), and in this country by A. R. Bennett, on an artificial cable in which the essential electrical conditions of a modern telegraph cable were reproduced. The length of the cable was about two hundred miles (200), having a resistance of 594·48 ohms, and a static capacity of 59·73 microfarads, the product being 35,508 K R, and with an ordinary double-pole receiver the conversation of any description could be carried on without effort."

Mr. Bennett will doubtless communicate with the originators of this statement. It may be added that the Editors of the Electrical Review not only heard of, but were well acquainted with artificial cables of the kind Mr. Bennett refers to, long before they heard of Mr. Bennett.—Eds. Elec. Rev.]

REVIEW.

Marine Boilers. By L. E. Bertin. Translated by Leslie S. Robertson. London: John Murray, 1898.

The author of this book is the Chief Constructor of the French Navy, and the work appears in English dress, introduced by Sir W. H. White, the Director of Naval Constru[illegible]

to the English Navy. At the present moment a book on marine boilers by so eminent a man as Mr. Bertin will possess a peculiar interest, seeing that the merits of the navy, of which he is so distinguished an official, have so nearly been in conflict with our own. Mr. Bertin's range of knowledge is evident from his work. The English Navy has not the monopoly of good men, while we know it has many poor men. We never hear people in the cock-sure vein about our own Navy, but we call to mind a certain engineer, who assured us evidently with satisfaction that the gold lace on his trousers "cost £10, sir, I was a terrible swell." How much is original of this book and how much has been added by the translator does not appear. We regret that while translating the French measures all through, a work which must have been a heavy task, the translator could not see his way to leaving the original figures side by side with the English. If ever we are to accept the metric system, its collateral presentation in such books as this would be a step in the familiarisation of engineers with the meanings. Trained in one system we always realise what is meant by a pressure of so many pounds per square inch, but without some practice, the statement in kilos per cm^2 has no meaning. We might describe this book as a series of freehand sketches with leading dimensions put in. It is not a treatise on the art of boiler making, though many details are given. Nor is it one upon strengths. It deals rather with the general principles of boiler making and with their treatment under steam, with weights, coal analysis, draught, closed stokeholds. In much of this it is a description of what has been done in various ships, and it collects within a narrow focus much information that is scattered in many papers; but, to English engineers, probably the chief interest of the book will centre in the latter half, in which various types of water-tube boilers are dealt with. The tubulous boiler has been at least, during late years so essentially connected with the French navy and French engineers, that probably a good deal of experience acquired by them is not yet in our hands.

The *Terrible* and *Powerful*, those huge cruisers of our own navy, whose distinguishing feature seems to be frequent visits to port to take in 2,000 tons of coal, are, as is well known, supplied with water-tube boilers. Much is said in their favour, and probably more remains behind to be said in an opposite sense. Of course it is no fault of the Belleville boiler that these two cruisers are double the size of many foreign ships of the cruiser type which carry heavier gun power. The tubulous boiler, in one form or another, is the boiler of the French Navy, from the torpedo boat to the battleship, and we can hardly think such a bold course would have been followed without good cause.

Whatever the true merits, it is desirable that the English Navy men should have at least an open mind in the matter of boilers, and that some definite answer should soon be forthcoming on the question of the best boiler for naval purposes. The author himself approaches his subject in a perfectly unbiassed manner. The durability of the Belleville boiler is not ascertainable. The boilers of the *Voltiguer* have been at work about 16 years, but as they may be said to have had in that time new lock, stock, and barrels at various periods, there is probably little or nothing left of the original boilers, and it is thus possible that nominally a boiler might endure a hundred years by repeated restorations of parts, just as John Smith remains John Smith all his life though he may have changed his entire corporeal entity every seven years.

Durability, however, is not a sole desirable quality of a boiler. Reliableness in action, &c., is more important, or one might quote the *Britannic*, which made better time after a life of 25 years with the same compound engines and shell boilers than when she first steamed out of Queenstown, and we do not know that she is not still so running, or that if reboilered it was not simply because of being remodelled for higher pressures. Weight seems to have been the principal determining factor in the choice of tubulous boilers, but we have seen no conclusive evidence that in saving weight, the efficiency has been maintained. Is it not rather the fact that the saving in weight is more than outweighed by the increase in the coal necessary to steam a given distance. The use of a lighter boiler can be understood for a French ship which owes its existence chiefly to a lack of cordiality in respect of England, and which may not require to steam over 1,000 miles at any time, but for an English ship with the certainty of long voyages, coal economy begins to tell, and a ton of boiler weight saved may soon imply a couple of tons extra coal allowance. The ratio of total weight of boilers per square foot of grate is as 4 to 5 for tubulous boilers and 8 to 11 for shell boilers, the difference being largely in the reduction of water contents. Boiler costs are also compared on a basis of grate area. The concluding chapters deal with accessories such as stop valves, filters, distillers to make up for water losses, water purifiers, the use of lime for getting rid of acids, a means first employed by the present writer about 18 years ago, and said to have been first employed about 20 years ago to kill the fatty acids from surface condensers, and various other items, including even ash hoists, though no mention is made of the means employed in closed stokeholds where ash and clinker is blown overboard by the air pressure of the forced draught, as possibly some of our readers may have seen on the new vessel of the Northwall route—the *Cambria*. Altogether this book is excellent. It is quite *sui generis* in its treatment, and, moreover, it is well illustrated and copiously indexed, though the illustrations are a little rough. The numerous tables are extended to lie wholly outside the volume.

LONDON COUNTY COUNCIL.

The Council on Tuesday resolved to lend £14,285 to the Islington Vestry for electric lighting purposes, and £12,000 to the St. Pancras Vestry for works of a similar character.

The Telephone Question.

The chairman of the Highways Committee asked for and obtained the permission of the Council to withdraw the recommendation made by the committee in regard to the long-span overhead telephone wires in Islington. In reply to questions as to the reasons for the withdrawal, Mr. Benn stated that the recommendation had been postponed from a previous meeting out of consideration for the Islington Vestry who had the matter in hand. The action of that Vestry being incomplete at present, it was desirable to withdraw the report in order that Islington might have a free hand in the matter.

Light Electric Railways.

The Parliamentary Committee submitted a report in relation to (1) the Finchley, Hendon, and District, (2) the Hampstead, Finchley, and Edgware, and (3) the Highgate, Finchley, and Wood Green light railway orders. The committee stated that they were of opinion that the schemes should be opposed, and that a similar course would be taken by the Middlesex County Council and by nearly all the local authorities affected. The committee therefore recommended that they should be instructed, in conjunction with the Highways Committee, to take the necessary steps to oppose the orders in question. The Earl of Onslow said that a part of the first line proposed would be within the county, and the other two were outside the boundary. They were to be worked by electricity, and were to be brought to junctions with existing tramway systems, and therefore that was the only way the Council could obtain a *locus standi*. The attitude of the Council was one of uncompromising hostility to the scheme, and the same policy prevailed last year. He thought, however, that the Council, in view of the congested state of affairs, should not oppose all schemes for building light railways to take people out of London. The noble lord said that he had intended to move that the report should be referred back to the Committee, in order that they might act in conjunction with the Middlesex County Council in regard to the matter, but as he had just been informed that negotiations were proceeding with that County Council, he would not move his amendment. If those negotiations were unsuccessful he hoped the chairman of the Parliamentary Committee would abandon his opposition to the present schemes, and allow them to be carried out by private enterprise. Earl Russell thought such an assurance could be given. Even if the applications for orders failed on the present occasion, they could be renewed in six months' time under the Light Railways Act. After some remarks by Mr. Beachcroft, Mr. S. Webb stated that many of the light railway schemes were being promoted in order to evade the purchase clause of the Tramways Act, 1870. The speaker continued that a clause should be inserted to secure the lines to London. Mr. T. B. Westacott hoped the Council would see that no company constructed a tramway or a light railway. If they were to have lines extending outwards, the Council should, in conjunction with the Middlesex County Council, undertake the work, or failing the latter, whose sympathy might, at all events, be obtained, the Council should be the authority. Mr. Bond could not gather from the discussion the reasons why the Council should oppose the schemes. Mr. Cornwall, chairman of the Parliamentary Committee, said that it did not matter whether the schemes were light railways or tramways, but it was very material upon what terms they were sanctioned. The Committee had had a conference with representatives of the Middlesex County Council, but he did not think it advisable to enter into the matters between the two Councils on the subject. The whole question of light railways or tramways in the outer ring of London or in Middlesex would be a matter of continued negotiations between the two Councils, and the speaker hoped they would lead to a satisfactory result. The recommendation was then put and declared carried.

Mechanical Traction on Tramways.

The Council postponed for one week the consideration of the following report by the Highways Committee:—

"We are of opinion that the time has arrived for an experiment to be made with some system of mechanical traction on the London County Council Tramways, upon any part of which we are informed that the Council, as the successor to the company and with the consent of the road authority or authorities concerned, can apply under an Act obtained by the London Tramways Company in 1888, to the Board of Trade for a license for the use for one year of such traction, the license being renewable by the Board on further application being made at the expiration of that period. It appears to us exceedingly desirable that, before recommending the Council to adopt any particular system with which to make an experiment, we should have the best expert advice and assistance obtainable; and we understand that Mr. A. Kennedy, F.R.S., is prepared to give advice upon the subject for a fee of 500 guineas, with an additional 100 guineas for travelling expenses in order that, before reporting upon the matter, he may make full investigation as to the systems in use in different places. Having regard to the very large financial interests involved in securing the most efficient, and at the same time economical, system or systems of working the Council's tramways, and also bearing in mind the high standing of Mr. Kennedy in his profession, we think that the Council would do well to employ him, on the terms stated, to advise as to the systems of mechanical traction best adapted for use on its tramways, not only as to those worked by itself, but those leased to the North Metropolitan Tramways Company. It is unlikely that Mr. Kennedy will be able to make his report before the end of the present financial year, namely, March 31st next, and we therefore propose to make provision for this item of expenditure in the maintenance votes for the year 1899-1900."

FORERUNNERS OF THE NERNST LAMP.

It may appear to some to be an invidious proceeding to depreciate a meritorious invention by hunting up real or apparent anticipations. But such a point of view, though adopted by one of the speakers in the discussion on Mr. Swinburne's paper at the Society of Arts, is more in the interest of the company promoter than of the public; and the former is usually much better able to look after his own interests than the latter.

A little research will show that Prof. Nernst, though he has apparently made a new departure in electric lighting, is by no means the first who has worked on the same lines. It appears to us, indeed, that his patent claims must, if contested, be taken as much narrower than they at first sight appear in his specifications.

Le Roux, Professor at the Ecole Polytechnique, Paris, was one of the first to discover that a brilliant incandescent light could be obtained from a rod of lime by heating it till an electric current passes through it. His discovery may have been accidental, and was merely a laboratory experiment; but in the *Comptes Rendus*, Vol. 66, A.D. 1868, p. 1,151, he states that if a cylinder of magnesia is pressed against the carbons of an arc lamp, in shunt with the arc, and held by a light spring, the quantity of light emitted was largely increased. When he examined the arc (fitted with the magnesia rod) through a smoked glass, the arc was seen to be replaced by a kind of luminous opaque mist, in which the points of the carbon could not be distinguished. Evidently the whole or the greater part of the current in the arc had been shunted through the magnesia when its temperature had been sufficiently raised by contact with the arc. Le Roux observed certain changes in the spectrum of this new light which led him to suspect decomposition of the oxides. In suggesting an explanation of this phenomenon, Le Roux asks: *Is it an electro-chemical decomposition exercised upon the conductor which has become a conductor owing to the rise of its temperature?* This suggested theory would not appear out of place in one of Nernst's specifications. For example, in Nernst's specification, No. 19,424, A.D. 1897, we read:—

"Now I have discovered that a large number of these bodies, which may be classified under the general expression of electrolytes or of conductors of the second-class (as compared with conductors such as metals or carbon, which conduct the current without any electrolytic action taking place and which are classified as conductors of the first-class) when used in a dry state though they are almost perfect non-conductors when cold, acquire so high a conductivity when once heated to an incandescent state, that a current of sufficient strength can be passed through them at ordinary low electrical pressures to keep them in the incandescent state."

The difference between what Nernst says he has discovered and Le Roux's theory, published 30 years ago, does not appear to be much.

The next important worker in this field was Jablochkoff, of electric candle fame. He appears to have observed that the incandescence of the kaolin between the carbons of his candle contributed perceptibly to the amount of light emitted. Whether or not this suggested the idea to him, he patented in 1877 (specification No. 1996) an incandescence lamp in which he used as the incandescent body a slab of porcelain, though he claims refractory materials in general in his patent.

This lamp is shown in fig. 1.

"It consists of a vice, C, the jaws of the vice holding between them the blade or slab of kaolin or porcelain, D, which with a width of about $\frac{3}{8}$ths of an inch will burn all night. The vice is arranged above an induction coil, B, and may be enclosed by a lamp glass or globe, the whole being made to resemble an ordinary lamp in appearance. The current from an induction coil, in passing through the slab, D, has not sufficient intensity to melt and burn the kaolin, but heats the same to the point of incandescence. The current is, in the first instance, made to act upon a kind of conducting match, placed on the edge of the kaolin slab. The part of the slab which is thus heated forms a conducting line of great resistance, and which, on the passage of a current of high tension, is raised to a white heat, giving out a fine light. A certain consumption of the kaolin is effected along

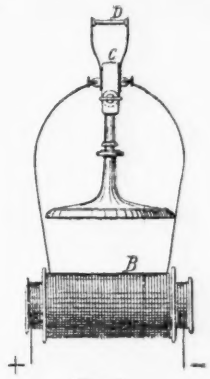


Fig. 1.

this line of incandescence, but the consumption is very small. The result thus obtained between the terminals of the circuit is a fine luminous band, which can attain a much greater length than the non-luminous spark ordinarily produced by the coil employed. The strength of the light only depends on the number of convolutions and size of the wire employed for the induction coil."

The induction coil mentioned by Jablochkoff would be more correctly described as a transformer, which he fitted to each lamp to raise the tension of the current sufficiently to pass through the "conducting match" placed alongside the kaolin slab. A thin layer of carbon powder and treacle appears to have been used for igniting purposes.* Mr. G. Hurlstone Hardy, writing in the *Journal of Society of Arts*, February 17th, states that he saw the Jablochkoff incandescent lamp in use at the Electrical Exhibition at the Albert Hall about 1879.

The resemblance of the Jablochkoff lamp to the Nernst lamp may be seen by comparing fig. 1 with fig. 2, which is the illustration of his lamp given by Nernst in his specification, No. 19,424, A.D. 1897.

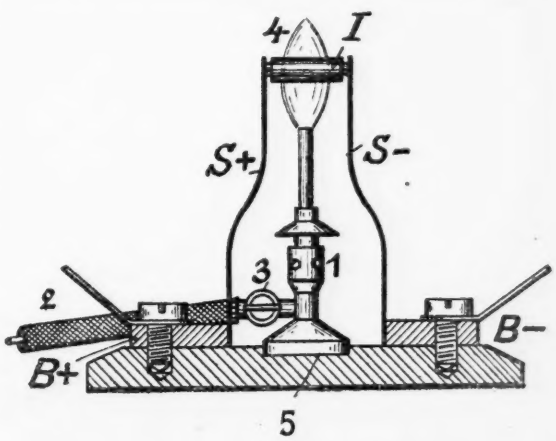


Fig. 2.

In this specification Nernst states that he has found by experiment that the oxides of magnesium, of zirconium, and of rare earths, are specially well adapted for use in his lamp. The description given of fig. 2 is as follows:—

"In the drawing, B +, B −, indicate binding posts, being connected with any source of electricity setting up a pressure of, for instance, 100—200 volts between them.

"S +, S −, are two elastic strips of metal of suitable section.

"1 is a small cylinder made of magnesia or any other suitable dry electrolyte, which itself forms the incandescent body of the lamp and the conductor between S +, S −. Preferably cylinder 1 is not enclosed in an air-tight globe but is open to the air, but this is not essential.

"The operation of this lamp is as follows:—

"When the pressure is set up in the binding posts, no current can pass through 1, because, when cold, its resistance is equal to many thousands of ohms.

"But as soon as the temperature of 1 is sufficiently raised, for in-

* *See* Hardy, *Journal of Society of Arts*, Vol. 47, p. 286.

stance, by applying a powerful gas flame, 4, for a few seconds, the conductivity of 1 is raised, and consequently a current is set up which immediately takes upon itself the function of the flame, and continues supplying the amount of heat which is being dissipated by radiation. Therefore the flame can be withdrawn, and the lamp will continue to glow like any ordinary electric glow lamp. A Bunsen burner, 1, is shown below cylinder 1 for heating it. 2 is a flexible gas tube leading to the burner, and 3 is a cock for turning on and off the gas. The base of the electric lamp has a centrally located recess, 5, into which the base of the gas burner may be set. This serves to properly locate the gas burner.

"In some cases I prefer not to withdraw the flame, but to continue heating the body, 1, by a flame and by the current simultaneously, thus obtaining a comparatively high amount of light with an exceedingly low expenditure of electrical energy, because the flame creates an atmosphere of very high temperature around the incandescent body, and thereby considerably reduces the loss of heat."

The heating of the refractory rod by a Bunsen burner, and the use of magnesia, zirconia, &c, are apparently important advances made by Nernst on the Jablochkoff lamp. But both external heating and the use of magnesia were made use of by Le Roux long before the date of the Jablochkoff invention, as we have shown above.

Besides No. 19,424, A.D. 1897, Nernst has taken out other two British patents, namely, No. 23,470, A D. 1897, and No. 6,135, A D. 1898. The former of these relates to devices for heating the refractory rod, in order to cause the lamp to light up, compressing external coils of platinum wire, reflectors for focussing the heat on the rod, cut-out devices for the platinum coil, and other like details.

No. 6,135, A D. 1898, which has only just been published by the Patent Office, is of considerable interest as showing the latest outcome of Nernst researches in connection with his invention. He says:—

"I have found from experiments that incandescence bodies of the above-mentioned kind, when made of pure substances, only attain a sufficient conducting power to act as an incandescence body when raised to a very high temperature, but that when these bodies are mixed, either with each other or with certain other substances, the conducting power rises considerably more rapidly with the increase of temperature.

"Thus pure oxides, such as those of magnesium, beryllium, zirconium, thorium, yttrium, and the like, still act as comparatively good insulators even when heated to 1,000° C. But if there be added to them certain other substances, or even if two or more such bodies be mixed together, their conducting power will be very greatly increased. Pure magnesia, for example, can only be brought with great difficulty to a state of electrical incandescence, but if only a small percentage of boric acid, calcium chloride, tungstic acid, or other suitable substance be added, the conducting power is increased to such an extent by heating that rods or filaments made of such materials can be rendered incandescence conductors with a pressure of 100 volts and less, even when only warmed with a slight flame, such as that of a match.

"Only bodies formed of oxides are enabled to permanently withstand the energetic action of oxygen at high temperatures, and in particular oxides of zirconium, and the rare earths related thereto, have given excellent results as regards durability, good light-emitting power, and excellent conducting power.

"Thus bodies composed of zirconium oxide, with an addition of about 5 per cent., or slightly more, of yttrium oxide, are very efficient; also bodies composed of thorium oxide, with an addition of about 20 per cent. of yttrium oxide, and bodies composed of thorium oxide containing 3 per cent. of zirconium oxide, 3 per cent. of yttrium oxide, and 0 3 per cent. of cerium oxide, afford very excellent results. Small quantities of erbium oxide and didymium oxide may also be advantageously mixed with the above-mentioned bodies."

It will be seen from this that Nernst has abandoned in his latest patent the use of magnesia, giving the preference to mixtures of oxides such as are used in the Welsbach mantle.

Another lamp belonging to the same class as that of Nernst is the "Lampe Soleil," which excited a considerable amount of interest about 20 years ago. This was a kind of a combination of the arc and the electrolytic lamp, but there can be little doubt now that it was mainly the latter, the arc merely acting as the preliminary heater. Marble, lime, granite, and other refractory materials were used in this lamp, but the preference appears to have been given to marble. Two carbon rods were inserted in a slightly convergent position in two holes in a block of marble, the ends of the rods just emerging at the lower surface of the block. An arc discharge was initiated between the rods across the surface of the marble, in much the same way as in the Jablochkoff kaolin lamp, by a perishable conducting thread or pencil. This gave the necessary preliminary heating to the surface of the marble, which thereupon became a conductor. The light emitted was of a yellowish colour, resembling that emitted by the Nernst lamp. Measurements made on the Lampe Soleil, showed that soon after starting the light decreased to about 60 per cent. of its original value. The current, and power required, also decreased, but in a less ratio. This is exactly what we would expect in an electrolytic lamp in which a current was sent through a relatively large mass of the refractory material. At first a narrow strip of the marble between the points of the carbons is heated to an extremely high temperature by the great intensity of the current passing through and becomes thereby a good conductor, the high temperature of the marble causing a large emission of light. As the heat in this central nucleus is conducted away by the surrounding mass of marble, the temperature is reduced, and resistance increased. This will reduce the current, and also lower the emission of light, as was found in the experiments cited.

It would appear from this that the Lampe Soleil was also an electrolytic lamp, but in a form much less efficient than either Jablochkoff's or Nernst's.

These investigations of the pioneers in this interesting field, to which attention has been again attracted, will help our readers, we hope, to form a just estimate of how much can be claimed by Nernst. His utilisation of the discovery of Welsbach in another field appears, as far as we know, to be his own, but there does not appear to be much more in his invention that has not been already put in possession of the public by previous inventors.

BUSINESS NOTICES, &c.

Advance in Prices.—Messrs. Ernest Scott & Mountain, Ltd., announce that owing to the unsettled state of the material and labour market, they are compelled to increase the prices in their catalogue, which are therefore to be considered approximate only.

Aluminium for Electrical Conductors.—The British Aluminium Company are drawing the attention of the electrical trade to the suitability of aluminium for employment as electrical conductors. They state that aluminium strip and wire having an electrical conductivity of 60 to 62 per cent. of that of copper, and copper being three and a third times the weight of aluminium, bulk for bulk, the same conductivity can be obtained with aluminium by increasing the section, whilst at the same time saving about half the weight as against copper. The company have themselves had aluminium wire and strip in use for electrical transmission at their Foyers works for some time past with satisfactory results. For good quantities of strip and wire for electrical work they are prepared to make specially low prices to compete favourably with copper, both as to price and conductivity.

Bankruptcy Proceedings.—The case of E. B. Pym, electrical engineer, late of Bar Chambers, Scarborough, and Branham Gardens, South Kensington, came before Mr. Registrar Brougham last Friday at the London Bankruptcy Court. The Official Receiver reported that the debtor was to have attended that day for public examination, but he was now at Burnham, in Somersetshire, and was without the necessary means to travel to London. His Honour pointed out that the assets included machinery to the extent of £100, and the travelling expenses could, therefore, come out of the estate. It was pointed out that the debtor had the machinery only on hire, and, although he had returned it as an asset, he had a further sum to pay before he became entitled to it. The examination was ordered to stand over for two months.

Dissolution of Partnership.—The dissolution of partnership is announced between Messrs. Kingsland & Edwards, of 139, Mostyn Street, Llandudno, as and from the 20th inst. The business will be carried on as heretofore at the same address by Messrs. Edwards & Armstrong. Mr. Kingsland will, we are informed, give his attention to electric traction work, and specially to the development of his own patents in connection therewith.

Liquidation Notices.—A meeting of the Electric Trust, Limited, will be held at the offices of Mr. E. R. Robson, 9, Bridge Street, Westminster, on March 20th, at 4 p.m., to hear an account of the winding-up from the liquidator.

At meetings of the New Motive Power Syndicate, held on January 30th and February 14th, it was resolved to wind up voluntarily on account of the provisional agreement passed by the syndicate in December, of Mr. G. A. Harvey, of the syndicate, with Mr. S. C. Lumsden. Creditors must send particulars of debts and the usual information to Mr. J. W. Roberts, 18, Eldon Street, E C., the liquidator, by March 31st.

Bedford Music Hall Lighting.—In reference to our note last week the electric lighting was carried out according to the specification and drawings prepared by, and under the supervision of, Messrs. Harrap, Hewett & Duffield, consulting electrical engineers, of Queen Street, E.C.

Books Received.—"Measurement and Weighing," by Edwin Edser. London: Chapman & Hall, Ltd. 2s. 6d.

"Dictionary of Electrical Engineering and Chemistry." Vol. II. English, Spanish, German, by Paul Heyne. Published by Gerhard Kühtmann, Dresden. (London: Messrs. H. Grevel & Co.).

Change of Address.—The Electric Tramway Equipment Company has removed its offices and warehouse to 36, Cornwall Street, Birmingham.

Damages.—On Tuesday before Mr. Justice Grantham and a special jury the Bristol Tramways and Carriage Company, Limited, was ordered to pay £250 damages to the widow of one Alesbury, who was killed by an electric tramcar colliding with a hay cart upon which he was riding.

Electric Crane.—An electrical overhead travelling crane has been put into the works of the Caledon Shipbuilding and Engineering Company, Limited, at Lilybank. It has a traverse of 40 feet 6 inches. Current for working it is provided from a dynamo developing 40 H.P., situated in the engine room. The crane will lift up to 40 tons.

Electric Launches.—Messrs. Laing, Wharton & Down, Limited, announce that they are now in a position to supply efficient electric launches for river or sea, they having taken up the representation of Messrs. Vril Launches, Ltd, for the sale of their boats for home and export. They have just built three boats to the order of the Imperial Russian Ministry of Marine. The last of these three

boats (32 feet long) ran for 5 hours at over 7 knots, and alternately for over 15 hours at 5½ knots. In the Vril system the special and exclusive features are:—The Vril storage battery arrangement, the Callow patent motor, the Callow-Eck patent controller, the Vril cabling system, the Vril hull designs for both river and sea work, Vril thrust blocks, bilge pump, stern tube, &c., special propeller for electric work. The works, situated in Brading Harbour, are fitted up with every requirement for boat building, and are now being considerably enlarged by the addition of several new and powerful electrically-driven labour-saving machine tools. Until March 1st, one of these launches is being exhibited at the Yachting Exhibition at the Royal Aquarium at Stand No. 27.

Electrical Engineering in Austria.—An Austrian Union Electrical Engineering Company has just been formed in Vienna to carry on the business of electrical engineering in general, and in particular to exploit the Thomson-Houston Austrian patents. Large works for the production of all kinds of electrical plant are to be established in Vienna.

Free Wiring.—The National Electric Free Wiring Company, Limited, have opened a branch establishment and showrooms at Market Place, Redditch, a contract for free wiring and hire purchase having been entered into between the Redditch Council and the company. A free wiring contract has also been entered into by the Tunbridge Wells Corporation with this company, and work is about to be started there. This company have recently received orders for extensions from the London County Council, the Metropolitan Fire Brigade, and from the trustees of the Duke of Bridgwater, for installation work at Bridgwater House. The contract for the electric light wiring and fittings for the new supply station at Walworth, for the Newington Vestry, has also been placed in the hands of this company. In addition to the foregoing, a complete installation of the electric light has been erected at the Free Church, Rotherhithe.

Incandescent Lamp Making.—At the conversazione of the students of the Technical College, Leonard Street, Finsbury, the "Robertson" Lamp Company gave a display of lamp making which showed in turn all the different processes of the manufacture of an incandescent lamp. The exhibition started with the squirting of the cellulose and went on through the various stages of manufacture up to sealing and exhausting the bulb, and was watched with great interest.

India-Rubber.—In some editorial comments upon the imports of India-rubber, the New York *Electrical Engineer* says:—"Four great classes of raw materials are habitually and necessarily taken into the States for manufacturers' use—raw silk, India-rubber, fibres, and hides. If the importations of these show a marked increase, it may be accepted as evidence of increased activity on the part of manufacturers. It is interesting, therefore, to compare the figures of the 11 months' importations in these great classes with those of earlier years. India-rubber, of which large quantities are used by electrical and other manufacturers, shows in 11 months of the present year a value of $22,831,578, against $19,270,633 in 11 months of 1897; $12,964,633 in 1896, and $17,473,848 in 1895. In all of the four great articles imported for the use of manufacturers, the importations of the year for the period covered by the above figures have been in excess of the preceding years, rubber being 50 per cent. larger than in 1894, silk 50 per cent. in excess of 1893, hides more than double that of 1896 or 1894, and fibres 50 per cent. in excess of 1894. When this increase in materials imported for the use of manufactures is considered in connection with the fact that the importations of manufactures have fallen in the year just ended from $283,000,000 in 1897 to $250,000,000 in the present year, it will be seen that there is good reason to believe that the manufacturers have been exceptionally busy." These figures have been drawn up by the Treasury Bureau of Statistics.

An Interesting Announcement.—We are asked to announce that English Industrials, Limited, have been appointed the sole representatives for the well-known electrical experts and manufacturers of central station and electrical tramway equipment, Messrs. Ganz & Co., of Buda-Pesth, who received, among other acknowledgements for perfection of scientific and practical design, the second prize at the competition for the equipment of the works of the Niagara Falls Electric Power Company. It is not intended to import the manufactured plant into this country, but arrangements have been made by which the whole of the construction and the execution of orders for central station and other contracts will be carried out in this country. Mr. G. E. Heyl-Dia, of Manchester, has agreed, for the present, to act as consulting engineer to the Ganz department of the company, until the English Ganz Construction Company takes over the whole of the business. The manufacture of Messrs. Ganz's plant will at present be carried out by Messrs. W. R. Renshaw & Co., in Stoke-on-Trent, under an agreement with this firm, but as soon as the financial arrangements have been completed, Mr. James Swinburne has agreed to act as consulting engineer to the Ganz Company, who will also have the advice of the scientific and practical staff of Messrs. Ganz & Co., in Buda-Pesth, especially of an authority on alternating currents, Mr. Blathy.

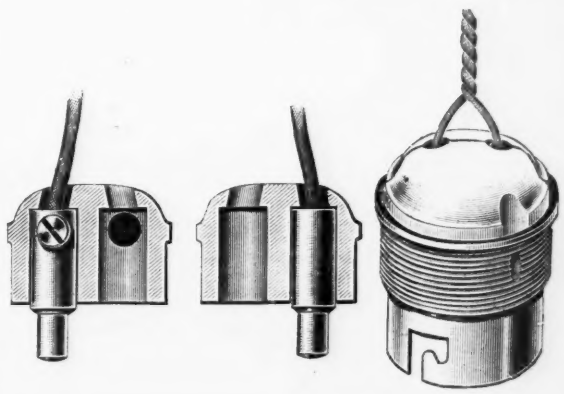
The Large Power Schemes.—Mr. W. Bromley-Davenport, M.P. for Macclesfield, has replied, in a letter to the town clerk of that borough to a resolution passed by the Town Council, calling the hon. member's attention to the various Electric Power Bills before Parliament, and asking him to oppose the principle of every one on the second reading. The hon. member states that he cannot admit that it would be proper for him to oppose Bills wholly unconnected with Macclesfield, nor can he accept the sweeping assertion that the principle involved in the Bills affects all Corporations, whether the towns are included in them or not. He continues: "The position of Manchester, for instance, which, through its Corporation, already provides the ratepayers with a supply of electricity, is not the same as that of Macclesfield, which does not possess any system of electric supply, and whose Council calls upon me to deprive the ratepayers of a favourable opportunity of obtaining such a supply. I cannot regard it as one of my duties as member for the Macclesfield Division, and as the Parliamentary representative of the ratepayers of the borough, to support the selfish aims of other municipalities to the detriment of my own constituents, especially if by so doing I involve them in an unascertained expenditure in opposing these Bills." Mr. Bromley-Davenport fears that the Macclesfield Council has not given the matter sufficient careful consideration, and points out that, while in Salford the average charge per unit was, according to evidence given in the Lords Committee last session, 6.25d. per unit, the Bill he was invited to oppose proposed to limit the price to 4d. per unit for the first two hours' consumption per day, and afterwards to 2d. per unit. He was glad to know that the resolution sent him did not represent the unanimous views of the Corporation, while it seemed to him that too much consideration had been paid to the interested views of other districts, and too little regard to the interests of the citizens of Macclesfield itself. Besides the uses of electricity as a power for tramways or machinery seemed to have been entirely overlooked. Painstaking study of statistics with regard to electricity made him feel bound to support the principle of the Bills in question, and the hon. member concludes:—"I should certainly support the insertion of clauses reserving the just rights and powers of the municipalities over the areas under their control, and I yield to none in my jealous regard for the authority of our ancient Corporations when wisely and beneficially exercised, and for their deservedly proud traditions."

It is expected that the second reading of the General Power Distributing Company's Bill will be taken on March 3rd.

Municipal Trading.—The North Staffordshire Chamber of Commerce objects to the principle of municipal trading in electrical fittings, and considers it desirable that a Joint Committee of both Houses of Parliament should go into the matter of municipalisation and define the scope permissible.

The Dewsbury Chamber of Commerce also had a discussion on the same question in connection with the letter being circulated by the London Chamber of Commerce (Electrical Trades Section). The communication was referred to the Dewsbury Corporation.

New Lampholder.—We illustrate Messrs. Williamson and Joseph's new patent high voltage lampholder for which they claim the highest possible insulation. The insulation is claimed to be strongest, where in too many lampholders it has been weakest, viz, where the flexible lead is attached to the plunger. The firm hold that it has hitherto been impossible to prevent possible leakage from the set screw to the lampholder case, but the present patent overcomes this difficulty. The porcelain is non-hydroscopic, and has



been subjected to the most severe tests before being adopted. The holder is also simple and easy to wire, besides which there exists the great advantage of the practical impossibility of "shorts" occasioned by the carelessness of the average wireman in leaving the flex loose, and so short-circuiting the same with the case.

New Premises.—The Electric Supply Stores, of Fore Street, E.C., have opened premises at 22, Dalston Lane, N.E., for the sale of electrical appliances.

Stegmann v. O'Connor.—On Saturday a Divisional Court of Queen's Bench, consisting of Mr. Justice Bruce and Mr. Justice Ridley, delivered judgment in this case on the plaintiff's appeal from the decision of an Official Referee, on the ground that the Referee's decision was against the weight of evidence. It will be remembered that in 1898 the defendant required an electric light installation put down at his house, and his architect prepared the specification. The contract was given to the plaintiff and he proceeded to execute it. During the course of the work, however, a complaint arose that the work was not being done according to the specification, and there was also a complaint that the plaintiff was not finishing the work in the time allowed by the contract, and the

work was then completed by another engineer, called in by the defendant's architect. The plaintiff thereupon brought the present action to recover the amount of his contract, and the Referee, while allowing the plaintiff a certain amount for the actual value of the work taken over by the engineer, awarded the defendant a penalty of £50 for the non-completion of the work by the plaintiff in the time allowed by the contract, and entered judgment for the defendant on the claim and counter-claim for £38 1s. Hence the present appeal. Their Lordships affirmed the decision of the Official Referee and dismissed the appeal, with costs.

Switches and Fuses.—The high tension switches and fuses (Verity & Steele's), described in our last issue, are, of course, being made and sold by Messrs. Veritys, Limited.

Theatre Lighting.—Under this heading last week we said that Messrs. Vaughan & Brown had just completed installations at the "Empress," Brixton, the Dalston Theatre, and the "Coronet," Notting Hill. This, however, is not correct, that firm only having put in gas, hydrants, and other work at these theatres, but not electric lighting plant. The whole of the electric lighting arrangements at the "Empress" and the Dalston Theatre, including a gas engine for the latter place, were carried out by Messrs. Strode & Co. The contractors for the "Coronet" Theatre were Messrs. Sax, Slatter and Co., and Mr. Thomas J. Digby is the theatre's consulting engineer. Messrs. Sax, Slatter & Co. were also the contractors for fitting up the Empire Theatre, Bradford.

Train Lighting.—Addressing the shareholders last week the chairman of the North Staffordshire Railway Company said that the electric light was being gradually fitted to their trains; three were fitted last year, and two more are now in progress

Utilising the Wind.—An electric lighting installation which has recently been laid down at Boyle Hall, West Ardsley, the residence of Mr. Simeon Colbeck, is interesting from the fact that wind is the only motive power employed for generating the current. The *Yorkshire Post* says that there are 50 sails, set radially in a circular frame about 30 feet diameter. A large pulley fixed on a horizontal shaft in an adjacent building drives the dynamo. The duty of this machine is to charge the storage cells, which are sufficiently large to run the 109 lights for about eight days in winter, should there be no wind for that length of time, and for more than a fortnight in summer. It is estimated that not more than three hours a week will be occupied in looking after the engine and dynamo.

ELECTRIC LIGHTING NOTES.

Abingdon.—A committee has reported to the District Council on the question of establishing an electric light installation for the town, but says that its information is insufficient to enable them to make a recommendation. An expert is to be engaged to help them to come to some conclusion.

Asylum.—The Richmond Lunatic Asylum is to be lighted by electricity. The Lords Justices have approved of the erection of an installation, at a cost not exceeding £3,000.

Bangor.—The City Council have received a letter from the Local Government Board sanctioning the borrowing of £14,050 for the purposes of electric lighting.

Barking.—The Lighting Committee will fit up a number of houses in Boundary Road, on the free wiring principle, as an experiment.

Basingstoke.—The Council last week decided to apply for a provisional order. The town clerk had interviewed the Board of Trade, and had been informed that the Board would grant no more licenses, but preferred that local authorities should obtain provisional orders in the ordinary course; also that the Board would view with disfavour proposals by local authorities to transfer orders to private companies.

Belfast.—After considering the city accountant's report upon last year's working of the electricity undertaking, the Electric Committee, which has recently had before it the question of reducing the charges for current, has decided to reduce the period of maximum demand from 1½ hours to 1 hour per day.

On 16th inst. there was another explosion in Ann Street in an electric light culvert, tearing up the road for a considerable distance.

The Corporation has decided to obtain a specification for the electric lighting of the Council Chamber, together with an estimate of the cost.

Bermondsey.—At the Vestry meeting on Monday, Mr. Cox, on behalf of the Electric Lighting Committee, reported the receipt of notice from the Board of Trade that objections to the granting to the Vestry of a provisional order had been lodged by the Thames Conservancy Commissioners, the County of London and Brush Provincial Electric Lighting Company, and the London Electric Supply Corporation. The Thames Conservancy Commissioners asked for the omission from the following clause of the Vestry's order of the words given in italics:—"Nothing in this order shall authorise the undertakers to interfere in any manner with the bed, soil, banks, or shores of the river Thames, or the navigation thereof, or affect in any manner the rights, powers, or privileges of the Conservators of the river Thames *without the consent of those Conservators*." When, however, the attention of the Conservators was drawn to the fact that they had agreed to the insertion of those words last year, they decided to withdraw their opposition with regard to the objections raised by the two companies, the Committee stated that the vestry clerk had forwarded replies thereto to the Board of Trade, and that they had approved his action in that respect. On the recommendation of the Electric Lighting Committee it was resolved to seal and present a petition against the Bill promoted by the County of London and Brush Company for powers to lay trunk mains through Bermondsey.

Blackburn.—The electric lighting works are reported to be progressing favourably, and they will shortly be opened.

On 9th inst. a trial trip was made over the new electric tramways by members of the Council and the press.

Bombay.—A correspondent says that there is a movement on foot to start electric lighting in Bombay, and a syndicate is being formed with the object of securing the public lighting, which is at present carried out by the Gas Company with incandescent burners.

Brentwood.—Considering the smallness of Brentwood, the Parish Council has decided to defer the question of electric lighting. They had gone into a report as to electric lighting in 56 towns in England.

Brighton.—The Lighting Committee has had under consideration the question of increasing the standard pressure in the electric light mains of the town, and concluded that it is advisable that the standard pressure in a somewhat extensive district in the north and east of the borough should be increased from 115 volts to 230 volts, and that notification be given to the Board of Trade of the intention of the Corporation to so increase it.

Bristol.—At the City Council last week the Electrical Committee asked for power to raise £25,000 additional capital for new machinery, &c., to meet next winter's demand. The loan of £75,000 authorised in 1896 had been, it was explained, expended in extending the generating station, and business was growing to such an extent that a further extension of appliances was necessary. Mr. George Pearson, chairman of the electrical department, spoke very hopefully of the future. A long discussion ensued as to the cost of the light, several members of committees having charge of libraries and the museum complaining that the electricity bill greatly exceeded that for gas lighting. On behalf of the committee it was replied that at some of these institutions the light was wasted by keeping all lamps burning when there was no necessity for it, and it was further said that where incandescent gas lighting was used there were repeated complaints of the mantles giving out. Mr. Pearson candidly stated that he did not pretend that electric lighting could be compared with gas for cheapness; his committee relied on the excellence of the article they produced, and experience proved that the public were willing to pay for a good article. In his own house he had found that his electricity bill was less than the bill when he used gas. The Committee had reduced the price 1d. per unit to private customers, and had reduced the cost of arc lighting in the streets 33 per cent, and would reduce the charges still further when business allowed.

The electrical engineer has submitted a specification for lighting the police-court, and he estimated £175 as the cost. The Finance Committee has resolved to ask for tenders.

Broadstairs and St. Peter's.—At a recent committee meeting convened to consider the application for a provisional order by the Isle of Thanet Light Railway Company, Mr. Murphy and Mr. Salter attended to explain the proposal. It was stated that the company would charge a maximum of 6d. per unit, the same as they had arranged at Margate. Extension of area was suggested by Councillors and agreed to. A report on the clauses is to be prepared by the clerk in conference with Mr. R. E. H. Fisher.

Cardiff.—The Workhouse Building Committee received a letter from an "independent expert," who stated that it would be more economical for the guardians to obtain their electricity from the Corporation than to erect a private plant. The question was deferred for six months.

Chelsea.—Last week the Vestry had before it a long report by the surveyor and the medical officer of health regarding the alleged nuisances from smoke, vibration, &c., caused by the Chelsea Electricity Supply Company in Alpha Place and Manor Street. The wording of the report leads us to the conviction that the local agitation was an exaggerated one. We quote the following:—"During our investigations we have not found any inconvenience to arise from any noise caused in working the station, neither have we found that the steam or the smoke issuing from the chimneys caused any nuisance to the surrounding neighbourhood. Complaints have been made to us of fine grit escaping from the chimney and being deposited on the roofs, doorsteps, and streets in the vicinity of the electric lighting station. We have ourselves observed the grit, and feel sure that on some occasions it is permitted to escape. This would, no doubt, be obviated by more careful stoking and regulation of the draught to the furnaces. It must be understood that this report is concerned with recent investigation of conditions which practically are still prevailing. We did not feel that it would serve any useful purpose to inquire into alleged nuisance, or damage to property, caused by the working of the station at times considerably antecedent to the commencement of this investigation."

Chester.—The Lighting Committee recommend that the Committee be authorised to have the necessary arc and distributing mains laid for supply of public and private lighting to Green Bank, Eaton Road, and Handbridge, the estimated cost, including eight Jandus arc lamps, &c., being £2,300.

Chesterfield.—At a recent Council meeting the Electrical Energy Committee recommended the provision of a generating station, and the supply of electricity for public and private purposes in the borough. They considered it advisable that such station should be in the unused portion of the gasworks, and that the Gas and Water Board be asked for permission to erect the requisite electrical plant on the board's premises on a lease, or on other terms to be arranged. They also passed a resolution in favour of the town clerk writing to Mr. Johnson, of Sheffield, asking whether he would be prepared, and on what terms, to advise the Council on a scheme, and to act as consulting engineer to the committee, and instructing the borough surveyor to apply to Messrs. Siemens Bros. & Co. and the Westinghouse Electric Company to inspect the borough and give specifications and estimates for providing an installation. These recommendations were adopted.

Colwyn Bay.—At last week's District Council meeting a report was submitted for the electric lighting of the central portion of the town at an estimated cost of £3,700. After some discussion it was decided to visit the refuse destructor at Llandudno, and at a future meeting to go into the whole question. The District Council after having had an official estimate that lighting the central portion of the town would cost £3,775, have decided to ask permission to visit the Llandudno electric light works and dust destructor.

Conway Bay.—The District Council has received a report from its surveyor on the scheme submitted by Messrs. Lacey, Clirehugh & Sillar. He goes into the question of buildings. The Council will visit the Llandudno electricity works before deciding upon the matter.

Dartford.—The Rural District Council have given their consent to the West Kent Electricity Supply Company obtaining an order to supply Crayford with electricity.

Derby.—At the monthly meeting of the Derby School Board on Monday the tender of Mr. E. Haslam, of St. Helen's Street, Derby, for electric light fittings at Orchard Street School was unanimously accepted.

Ealing.—At a recent District Council meeting, the Electric Lighting Committee having gone into the detail of the tenders for the new plant at the electric light station, recommended that Messrs. Siemens Bros. & Co.'s tender for two 450-B.H.P. Siemens alternators with Belliss engines, for the sum of £6,786, be accepted, subject to clauses having reference to holding down bolts and plates, and delivery of and placing machinery on foundations, being struck out altogether. The question of motor alternator was adjourned for further consideration. The Committee asked the Council to give them power to substitute the Browett-Lindley engine in Messrs. Siemens's tender, at a cost of £300 extra, should any difficulty arise with Messrs. Belliss with reference to the deletion of the aforementioned clauses. The report was adopted.

Eastbourne.—The offer of the Town Council to purchase the undertaking of the Eastbourne Electric Light Company, Limited, for a total sum representing £20 for each nominal £10 share was submitted to a meeting of the shareholders on Saturday, and was practically rejected. The meeting was simply a meeting between the directors and the other proprietors of the company for a free exchange of views as to the proposals of the Corporation. Upon the whole, the meeting appeared to be favourable to the sale of the undertaking, but on the question of terms there was a feeling, especially among recent purchasers of shares (some of whom had bought at between £14 and £15), that the advance of from 33 to 40 per cent. was inadequate. The views of the directors as to the basis of calculation on which the offer should be made was considered, and a deputation was appointed to make further representations to the Electric Light Committee.

Farnborough.—The District Council has had correspondence with the Power & Traction, Limited, with reference to the proposed electric lighting order for Farnborough. On 23rd inst. a representative of the company was to appear before the Council, when an expert was also to be in attendance to guard the Council's interests.

Fort William.—Negotiations are at present in progress between the Burgh Commissioners and the Electric Lighting Company, with a view to the latter obtaining the use of the town's surplus water supply, which it is proposed to retain as a reserve against any probable failure in connection with their supply from the River Kiachnish. The Electric Lighting Company are also, it is understood, making arrangements for the extension of the lighting system to Banavie and Corpach. The current is to be conveyed to these villages by means of overhead wires, and the cost of the extension is estimated at about £900.

Govan.—A deputation from the Council went to Llandudno last week to see the electricity works, which Mr. A. H. Preece explained to them.

Galashiels.—The Works Committee has reported that the local directors of the British Boot Industry, Limited, have suggested that ample power and accommodation could be had at Nether Mills for the development of electricity. The committee have asked that it be remitted to them to consider the whole subject of illuminating the town by means of electric light. The Council has agreed.

Glasgow.—Last week Bailie Maclay, in moving the adoption of the minutes of the Electricity Committee, said they had now entered into contracts for the erection of the new works in Pollokshaws Road. They had also accepted offers from certain engineers for new plant for the Port Dundas station. It was almost certain that it would be eight or nine months before the new works could be completed, and that brought them dangerously near the supply for the next winter. There was, therefore, not a moment to lose, and the committee would push on the work as rapidly as possible. The minutes of the Electricity Committee stated that, after receiving the amended report of the engineer as to the value of the undertaking of the Kelvinside Electricity Company, the sub-committee agreed, by seven to three, to offer £30,000 for the undertaking. The Corporation approved.

Hastings.—Last Friday the Council adopted the report of the Public Lighting Committee, which stated that the purchase of the undertaking of the Hastings and St. Leonards-on-Sea Electric Light Company had been duly completed, the total sum paid being £62,095, made up as follows:—Purchase of undertaking, £54,800; new machinery, alterations to buildings, &c., carried out by the company since the date of contract to purchase (July 23rd, 1897), £6,547, the remainder was for sundry purposes. A sub-committee, appointed to undertake the management of the electrical department, has been settling various details in regard to the working of the undertaking. The Council take over, as borough electrical engineer, Mr. L. Andrews, at £350 per annum, Mr. C. W. Kennaway, as assistant engineer, at £120 per annum, and others. Prof. Kennedy will continue to act as consulting engineer, at a retaining fee of 50 guineas a year. Application is to be made to the Local Government Board for the £4,095 in excess of the loan already sanctioned for the purchase. The Council has decided to charge for any amount up to 20 units 13s. 4d., and for each unit over 20 units 8d. The borough electrical engineer and Prof. Kennedy have reported upon extensions to mains, &c., and the Council has adopted the recommendation of the sub (management) committee that the whole of the works specified in those of the electrical engineer be carried out in due course, and that application be made to the Local Government Board for sanction to the borrowing for a period of at least 30 years, of the sum of £32,768, the total estimated cost of the works, viz.:—

New plant and machinery, extension to buildings, changing to sub-station, system of mains, extension of mains as specified in the electrical engineer's report of January 30th	£22,184
Extension of mains, &c., as specified in the electrical engineer's report of February 14th	10,584
	£32,768

The question of adopting some method of free and easy wiring is being considered. The committee have had before them tenders which, having regard to the urgency of the case, have been obtained by the electrical engineer for the supply of a new engine and alternator required in connection with the extension of the electric light works, and they recommend that the tender of G. E. Belliss & Co., Limited, of Ledsam Street, Birmingham, for the supply, delivery and fixing of one of their "quick revolution enclosed tandem, compound three-crank equal angle standard tec. 4 patent self-lubricating" engines, and for the fixing of an alternator at the sum of £1,385, —and the tender of the Brush Electrical Engineering Company, Limited, a "Mordey-Victoria" alternator, capable of developing 200 kw. at 353 revolutions per minute, at 100 periods with solid half-coupling but without exciter, at the sum of £1,280, be accepted subject to the respective companies assenting to the terms of the general specification and conditions of contract prepared by the electrical engineer. In his report, Mr. Andrews recommends the continued use of Brush alternators for extensions at the works, because they are likely to run in parallel better with the existing machines than with any other type of generator. The various new plant, feeders, &c., suggested in his report are estimated as follows:—

Engines and alternators, &c.	£6,500
Secondary batteries	350
Extensions to buildings	5,500
Changing over to sub-station system of mains ...	6,080
Duplicate high tension feeders	884
Extension of mains to new Music Hall	920
Extension of mains to Christ Church, Blacklands...	1,950
	£22,184

These recommendations and estimates were adopted.

Hebden Bridge.—Salem Chapel is to be lighted with 123 16-C.P. incandescent electric lamps. Mr. R. S. Blackburn has the work in hand.

Hendon.—The District Council will not reconsider its decision not to allow a private company to secure a provisional order.

Hove.—The Town Council has decided to fit incandescent gas burners to the lamps in Western Road, and the lighting by electricity as at present is to be discontinued. It was stated that electric lighting had proved too costly.—Alderman Reed said that during the last 12 months the electric light in the Western Road had cost £161 13s. 4d., while, if they filled up the road with the incandescent lights, they would get a vastly increased light for £95. Presuming that they decided to adopt electric light for the Western Road, they would have to put up electric standards, which would cost at least £280, while for the new incandescent lamps they would only have to pay £122.

Huddersfield.—At the Council last week the electrical engineer reported that the sum of £1,200 had been expended in the conversion and renewal of consumers' appliances. It was resolved to debit the amount to the depreciation and contingencies account, and to credit the mains and services capital account with a like amount. The borough accountant has submitted the revenue for the 12 months ending December 31st, 1898, from which it appeared that there was a balance of income over expenditure of £2,437 1s. 3d., which the committee decided to transfer to the depreciation and contingencies account to meet future expenditure which might be determined on. The number of consumers in February was 824, an increase of 18 on the month; lamps connected, 54,778, an increase of 624 on the month; and units metered in January, 101,583, as compared with 82,590 in the corresponding period last year. Accounts amounting to £834 16s. 8d. have been passed.

Kingswood.—At last week's Urban Council the clerk said that as clerk to the Urban District Council of Kingswood, a writ had been served upon him at the instance of the Western Counties Electric Light and Power Syndicate, Limited. The plaintiffs' claim was for specific performance of an agreement to purchase the electric light plant and installation at Kingswood. In the alternative the plaintiffs' claim was that the defendants be ordered to affix their common seal to such contract to purchase. In the further alternative the plaintiffs' claim was damages for breach of contract to purchase. The writ was issued by Wansbrough, Dickinson, Robinson & Tayler. An appearance had to be entered within eight days. It was served upon him on the 10th inst., so that he must enter an appearance on the morrow. It was resolved that the clerk be instructed to enter an appearance and take the necessary steps to defend the action.

Lancaster.—This week the Corporation have decided to reduce the price of current for motor purposes from 4d. to 3d. per unit, and for private lighting purposes from 5d. to 4½d. per unit.

Leominster.—The Town Council is to consider the electric lighting question shortly. There was a brief discussion last week on the lighting question.

Lincoln.—On 15th inst. a Local Government Board inquiry was heard into the Council's application for a £19,000 loan for electric lighting. It was explained that the Corporation borrowed £20 653, and the whole of that sum had been spent, or is in process of spending. The current obtainable was equal to 5,000 8-C.P. lamps, but the demand for the light already reached 6,000, and it was considered certain there would be a large increase yet. The Corporation thought it necessary to cable an additional 10 miles, and that would necessarily involve more engines, dynamos, and boilers at the generating station, where provision and developments had been made. The length of cables already laid was 4¼ miles.

Llandudno.—The Penrhynside Parish Council has asked the Llandudno Urban Council upon what terms they would supply them with either gas or electric light for public lighting purposes.

The Council has decided to charge 3½d. per unit for current for power purposes. Mr. Morton and Mr. Stephenson have reported with reference to the working of the electric lighting and refuse destructor works. Mr Morton reported that the benefit derived by the electric light works from the refuse destructor would be about £50 per annum, providing that the refuse should be burnt at such time that they might derive the full benefit of the steam. Mr. Stephenson supplemented Mr. Morton's report with particulars as to the refuse destroyed and the cost of labour, &c. The total estimated number of tons per annum might be taken at 5,803 tons, and the cost £368. So that steam might be generated when most needed, the destructor should be under the control of the electric light engineer.

Lowestoft.—Mr. W. C. C. Hawtayne, in a confidential report to the General Purposes Committee on the subject of the supply of electricity for electric traction, made certain suggestions, and the committee recommended "that 2d. per unit be charged for all electricity supplied to the Light Railway Company, the electricity to be measured by meters at the electric supply works." The General Purposes Committee report that Mr. Hawtayne has approved of the electric lighting system described in a communication from the Board of Trade in the following terms:—"A continuous current direct supply for public and private lighting and power purposes, at a constant pressure not exceeding 500 volts across the outers of a three-wire system, the intermediate conductor being, with the approval of the Board of Trade, connected with earth at the generating station, but insulated at all other points. The mains will be separately insulated cables partly externally protected with a lead sheath and an armouring of steel tape and laid directly in the ground and partly drawn into iron or stoneware pipes or conduits, efficient means being provided to keep all pipes and conduits free from water and gas."

Margam (Glam.)—Last week the District Council agreed to light the district with electricity at a cost of £6,500, providing for the lighting of 1,000 lamps.

Merthyr.—The District Council last week considered a letter from the British Electric Traction Company, setting forth amended terms for electric lighting. The Council determined to enter into an agreement with the company upon these new terms.

Morecambe.—The District Council, acting on the recommendation of the Electricity Committee, have decided to reduce the price of current from 6d. to 5d. per unit from April 1st, and it is hoped that the demand will admit a further reduction in price before next winter. The installation of the light upon the West-End Pier, Morecambe Tower, and the Central Pier is being rapidly proceeded with. The tender of Messrs. Callender's Cable Construction Company has been accepted for services to street incandescent lamps. The sum of £4,789 has been paid to Messrs. T. Parker, Limited, who have completed the first contract for the installation of plant. Messrs. Stoddart's system of free wiring at a charge of 1d. per unit to consumers has been adopted after a good deal of discussion.

Newcastle.—A letter has been addressed to the Corporation by the Newcastle Electric Supply Company, remarking upon the scattered distribution and limited use of the arc lights in Newcastle. The secretary says:—"In the hope that the Corporation will adopt it to a greater degree, the company are willing to supply and maintain the electrical equipment to lamp posts, the latter to be provided and placed in position by the Corporation, and electrical energy to the extent of from 460 to 500 watt-hours per lamp for 4,000 hours per annum at the rate of £18 net per lamp." This is a considerable reduction upon the present payment for the arc lamps.

Newington.—The vestry clerk announces that he has already received applications for over 10,000 8-C.P. lamps, although the mains are only now being laid. When the Vestry applied for their provisional order not more than this amount was estimated.

The Vestry will extend the electric light mains in South Place to St. Agnes' Place for the lighting of St. Agnes' Church, which is already wired.

Oldham.—Another generating set (Siemens-Willans), making the ninth, is now being put down at the electricity works, and a tenth is on order. These will occupy all available space at the station. The committee have not yet come to a decision *re* site for new works. During the past 12 months the demand for the light has increased considerably. Then there were 20,500 8-C.P. lamps, but now there are 27,500, or an increase of 7,000 during the year. The new machine will not be required to meet present demands, but is wanted more as a reserve in case of a breakdown. Each dynamo is capable of supplying 3,200 lights. It was decided by the committee last week to recommend the acceptance of Messrs. Holden & Brooks' tender for an injector, &c., and of a tender for seven miles of cable from Messrs. Callender's Cable and Construction Company, at £280 per mile.

Paddington.—At Tuesday's Vestry meeting the Electric Lighting Committee recommended "that inasmuch as counsel is of opinion that the application of the Metropolitan Electric Supply Company to lay down trunk mains through Paddington should be resisted, on the grounds that it would greatly complicate the question of purchase should the Vestry hereafter decide upon requiring the works of the Paddington undertaking, the Vestry do not grant such application, and that the committee be empowered to instruct the solicitor to oppose the same, and if necessary, to employ an expert to advise them in the matter." This was agreed to.

Paisley.—A deputation from the Partick Council has inspected the new electric lighting station in course of construction here.

Peterborough.—At the Council meeting last week the city engineer presented plans and specifications of plant in connection with the electric lighting works, and instructions were given for the invitation of tenders to carry out the same.

Rochdale.—The town clerk has received from the Local Government Board official sanction for a £30,000 loan for electric lighting purposes.

Rothesay.—The Town Council has agreed to proceed with a scheme of public electric lighting for the front of the town, with a view to having it ready for July next. The scheme includes the lighting of the harbour and the shores from the Aquarium on one side of the bay to the Skeoch Wood on the other.

Rugby.—The Council will oppose the Leicestershire and Warwickshire Electric Supply Bill.

St. Pancras.—The Vestry at the meeting on Wednesday authorised the Electricity Committee to get the premises of the labour bureau wired for electric lighting. It was decided that the accounts of the electric lighting department should be audited by Mr. Bellamy, accountant to the Vestry. The question arose consequent upon a consideration as to whether a chartered accountant should be engaged for the purpose, but it was found that Section 105 of the Metropolis Management Act, 1855, is stipulated in the Electric Lighting Act of 1882 as providing for the method of audit to be carried out by the accountant to the Vestry. It was resolved to extend the supply mains to Cumberland Market at a cost of £634, and to petition against the Bills promoted by the National Telephone Company.

Shoreditch.—The Vestry on Tuesday authorised the clerk to oppose the Bill promoted by the County of London and Brush Electric Lighting Company. After considerable discussion, it was resolved to increase the salaries of Mr. G. Kemp, chief assistant engineer, and Mr. H. T. Roscoe, superintendent of mains, from £3 per week to £180 per annum as from the 25th ult., and further by annual increments of £10 to a maximum of £200. Upon the advice of the chief engineer it was decided to instruct the British Insulated Wire Company to supply and lay cable for a service to the works of Messrs. Waterlow, and to order a new booster from the Electric Construction Company for £399, and to get the same company to rewind the arma-

ture of the present booster for £41. With regard to the proposed new switchboard, it was decided to ask two or three firms to tender for the contract.

The Local Government Board has authorised the Guardians to spend £2,000 upon an electric light installation for the Workhouse, Infirmary, Casual Wards, and Dispensary.

Shrewsbury.—The Town Council has adopted a report by the Water and Lighting Committee in which it is stated that they are unable to report the completion of the purchase of the electric light undertaking from the Shropshire Electric Light and Power Company, Limited, in consequence of certain difficulties having arisen in connection with the conveyance of the property of Messrs. Edmundsons', Limited, who are interested therein. Settlement of these will necessarily demand some time and consideration. Messrs. Edmundsons will carry on the works for the Corporation from January 1st last, and will continue to do so for a fortnight after the electrical engineer appointed by the Corporation has taken up his duties. The Committee advertised for an electrical engineer and manager, 51 applications being received, and Mr. C. Johnston, of Lancaster, has been appointed at a salary of £250, he to be allowed to have half the premiums of two pupils. The recent exceptionally high flood caused a temporary stoppage of the works for a portion of one day, the flood water having percolated into the main flue of the boilers, which flue is situated about 6 feet below the boiler and engine house floors. This flue is to be made watertight.

Southwold.—Mr. Leo Francis has submitted a comprehensive scheme to the Council for lighting up the town with electricity. It was considered by the committee last week.

Sunderland.—The Guardians have instructed Messrs. W. & T. R. Milburn to prepare a specification for making provision for lighting the new Infirmary at the Workhouse with electricity, as *per* their report of December 27th, at a cost of £976, and tenders for the work are to be invited.

Swansea.—The Council has considered the Electric Committee's recommendations respecting the electric lighting of the town at a cost of £54,000, and adopted them.

Taunton.—At the last Council meeting the Electric Lighting Committee presented the statement of accounts for the electric lighting for the year ending December 31st last, showing a balance to the good on net revenue account of £794 11s. 9d. They recommended that the salary of the electrical engineer should be increased to £200 a year. The electrical engineer, Mr. E. B. Thornhill, informed the Council that during the past year the equivalent of 4,754 8-C.P. lamps had been connected with the mains.

Whitechapel.—The District Board last week referred back for further consideration a proposal from the Electrical Committee made in the following terms:—"To consider the suggestions made by a letter from the London County Council on the proposal of the Board to borrow the sum of £60,500 in order to carry out that portion of the work of erecting an electric lighting installation in this district as contemplated by the report of Mr. Wright, the electrical engineer, and to renew such application upon the terms following—namely, 'That such loan be upon the instalment system, and not upon the annuity system as at first proposed by this Board, repayable in 42 years with interest at the rate of 3 per cent. per annum, provided that not less than £10,000 be taken up at one time, and upon the understanding that if any works fail to be renewed during the currency of the mean period, the cost of renewal shall constitute a maintenance charge and shall not be made the subject of a fresh loan, and that the repayment should commence at the expiration of three years from the quarter-day anterior to the date of the advance of the first portion of the loan; and that the resolution passed by this Board at their meeting held on January 16th last be varied accordingly.'"

Wolverhampton.—On Wednesday last week a Local Government Board inquiry was held regarding the proposed loan for £29,740 for electric lighting. The town clerk explained that the money was for carrying out a scheme with respect to the generating stations, the mains and distributing system, and also the sub-stations. The capacity of the generating plant was equal to 622 kw., the capacity of the transformer or distributive plant was equal to 315 kw. There was a further capacity of 46½ kw. in respect of a subsidiary sub-station in Chapel Ash, containing two transformers, the object of which was to raise the pressure from 110 to 220 volts in the Chapel Ash district. There was a small storage battery at the Town Hall, with a nominal capacity of 45 kw.-hours. The total length of feeding and distributing mains, as at present provided, was as follows:—Feeders, 830 yards; distributors, 7,530; trunk mains, 1,500. The maximum demand during the present winter occurred on December 21st, and amounted to 420 kw., which, setting aside one of the 140-kw. generators as spare plant, represented practically 90 per cent. of the total available capacity. The maximum demand for private lighting made on the transformers was 330 kw., representing about 95 per cent. of the full capacity. The difference between the figure given as the maximum demand on the transformer, and that given as the maximum demand on the generator is 120 kw., of which 30 kw. is accounted for by the existing system of street lighting, and the remainder 90 kw., representing losses on the transformation and feeders. The figures give a total working efficiency of 77 per cent. The maximum demand upon the generating station for the year 1897 was 318 kw., showing an increase for the year 1898 of about 32 per cent. The town clerk also stated that at the present time the system in vogue in Wolverhampton was the high tension continuous current, but it was intended to develop the two-wire into a three-wire system. In the new districts to be supplied, the three-wire system would be adopted immediately. The number of consumers in the borough at the present time was 270; the number of units supplied for the year ended March 31st, 1898, was 291,233. If there was the same ratio of increase during the coming year the plant would be inadequate. That was one reason for the proposed extension, and another reason was, that it was proposed to extend the domestic lighting along the Tettenhall Road, and also to extend the street lighting along the same road. It was also proposed to give facilities to manufacturers in Horsley Fields for motor purposes and heat. In that particular district consumers would be supplied direct from the generators, whilst the more distant and outlying portions of the borough would be fed by the existing high tension system, by means of transforming sub-stations controlled from the switch station in the Town Hall. So that at the generating station there would be two separate and distinct generating systems—the high and low. The Committee were of opinion the combination of the two systems would increase the efficiency of distribution, minimise the risk of a breakdown, and greatly facilitate the system of electric traction, which sooner or later would be adopted when the Wolverhampton tramways had been acquired by the Corporation. The Committee further thought that the altered system would effect a reduction in the cost of generating and distributing electrical energy. When the scheme was carried into effect the capacity of the boiler power would be increased 50 per cent., the kw. capacity or generating plant 70 per cent., storage battery 950 per cent., length of feeders 500 per cent., and length of distributors 75 per cent.—Mr. J. H. Shawfield (the Corporation electrical engineer) then gave details, and said no cable would be taken up nor any permanently abandoned. A few alterations would have to be made upon the change of system, notably the fittings to some present consumers, on account of the altered pressure.—The inspector: Has any of this work been carried out?—Mr. Shawfield added: The only work which had been completed was the refrigerator (exchange) sub-station, which was necessary, and tenders had been accepted for two steam dynamo sets for the 200-cell battery, and the feeders, network boxes, &c. Unless this had been done, it would have been impossible to make due provision for next winter.—Alderman Mander remarked that it had been absolutely necessary to take the steps in advance in order to avoid the risk of a breakdown. One of the main reasons of changing over to the higher voltage was that it would act as a "standby" to the tramway service.

Yarmouth.—On the advice of the surveyor, the Town Council has resolved that 30 new arc lamps be provided, their position to be fixed at a future meeting.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Barking.—The *London Gazette* announces that the Board of Trade have, after modification, confirmed an order made by the Light Railway Commissioners, and entitled the Barking and Beckton Light Railways Order, 1898, authorising the construction of light railways in the County of Essex, between Barking Town and the Beckton Gasworks.

Barnsley.—The Town Council is shortly to consider a suggestion to appoint a Tramways Committee to consider the advisability of introducing a system of tramways into Barnsley.

Boston Elevated Road.—Ground has been finally broken on Boston's new elevated road which will connect two widely separated districts, and, most important of all, unite the two new Union stations. The road will begin at Sullivan Square, in the Bunker Hill district, and will then proceed down Main Street, across the Charles River, until the North Union Station is reached. Then, says the *Scientific American*, after making a turn, it will run along Atlantic Avenue and finally reached the New South Union Station, after which it will continue up Washington Street until Dudley Street is reached. The entire distance from Sullivan Square to Dudley Street, which is in the Roxbury district, will be about 10 miles. Of course the subway will really form a portion of the line. Electricity will be used as a motor power; a third rail will be used. Branch lines to other suburbs will be built later on. It is expected the work will be completed in about two years.

Coatbridge and Airdrie.—The Coatbridge Council had a discussion some days ago with reference to a letter received from the British Electric Traction Company, Limited, stating that although the examiner on Bills had reported against their Bill, the company hoped and expected the Standing Orders Committee would allow the Bill to proceed this session. To meet the requirements, they had now lodged plans. Councillor Bruce gave notice of motion for next meeting, that in the event of the scheme of the British Electric Traction Company, Limited, not passing in Parliament, the Council appoint a committee to consider, with a committee of the Town Council of Airdrie, as to the prospects of a scheme to form a trust for the purpose of constructing a tramway for the burghs of Coatbridge and Airdrie.

Cork.—Last week a meeting of the Judicial Committee of the Privy Council was held at Dublin Castle for the purpose of hearing an application from the Cork Electric Tramway Company for the sanction of an extension of their system at Cork from Victoria Road to Ballintemple. The application was granted.

Aberdeen.—Last Monday the Council was to consider a report by the Tramways Committee on the mechanical traction question. The committee unanimously recommended that the Woodside section should be equipped on the electric trolley system, and that double-deck cars be employed. The burgh surveyor and the electrical engineer have drawn up a report upon the best method of carrying out the work of doubling the line from Kittybrewster to Woodside, and of equipping the whole length between Union Street and the terminus at Woodside for electric trolley traction. They say that the portion of the permanent way between Union Street and Kittybrewster, which was doubled in 1894, is laid with steel girder rails 7 inches deep, weighing about 90 lbs. to the lineal yard, on a concrete foundation 6 inches in depth. These rails will last for a number of years, but they will require to be bonded. The permanent way between Kittybrewster and Woodside (Section No. 2) will be practically of the same construction as Section No. 1, with the exception that the rails will be of a heavier section and in longer lengths. They recommend the span-wire system for Section No. 1, supporting the span wires as far as possible from ornamental rosettes fixed to the houses along the route. Where this is impracticable it is proposed to erect side poles, which will be also available for the purpose of lighting the street by means of arc lamps. Provision has been made in the plans deposited in connection with the proposed provisional order for the doubling of Section No. 2 to construct a 6-feet way between the two lines, and in this section it is proposed to erect centre poles in the 6-feet way fitted with ornamental side brackets to carry the overhead conductors. There is nothing to prevent the equipment of Section No. 1 being proceeded with immediately, and they recommend that offers for the supply of the necessary materials and for the erection of the works should be taken at once, and that orders for the rails, fish-plates, and bolts, as well as for the poles, cables, conductors, bonds, and all other necessary materials to complete the electrical equipment of Section No. 2 should also be placed without delay. They further recommend that the orders for the eight electric cars should be put into the makers' hands at the same time. The placing of these orders at once is most essential. There are at the present time such a number of other towns, both at home and abroad, proceeding to equip their tramway undertakings in the same manner as Aberdeen, that the special manufacturers who supply the materials required have their hands so full that considerable time must elapse after placing the orders before delivery of the materials can be expected. They estimate the cost of the works and plant required as follows:—

Reconstruction of line (section No 2)	£13,271	15	0			
Supply and erection of electrical gear, including bonding (Sections Nos. 1 and 2)	10,335	0	0			
				£23,606	15	0
Eight double-deck cars	£4,800	0	0			
One spare truck with motor ...	310	0	0			
Alterations on shed and stables at Woodside, repairing shed, &c.	1,000	0	0			
Alterations on existing arc lamps	300	0	0			
	£6,440	0	0			
				30,046	15	0
Add for contingencies, say				3,253	5	0
				£33,300	0	0

Appended to the report is a comparative statement "showing the result which might be expected by the conversion of the Woodside section from horse haulage to electric traction." The statement shows for horse haulage a capital account, including some £22,000 for lines, of £38,580. The capital account for electric traction is given as £57,600, which includes £33,000 as expenses of renewing lines and electric equipment, as per engineer's report. The City Chamberlain, in a detailed estimate of the revenue and expenditure account, shows on horse haulage a deficiency of £549, and on electric traction a surplus of £254.

Doncaster.—On 15th inst. an inquiry into the expediency of granting the Corporation of Doncaster permission to construct and work a system of light railways in the borough and neighbourhood of Doncaster, was opened by the Light Railways Commissioners. The town clerk conducted the case for the Corporation, and there were also present, on behalf of the Corporation, the borough surveyor (Mr. Crabtree) and Mr. J. N. Shoolbred (consulting electrical engineer to the Corporation). Mr. Sydney Morse represented the British Electric Traction Company. The town clerk said the proposed railways were eight in number, and they had a total length of 7½ miles. The estimated capital sum required for the construction and the electrical equipment of the system was £70,000. The effect of the scheme would be to enable the residents in Balby, Hexthorpe, Bentley, and Wheatley, which were outside the borough of Doncaster, to have direct communication with one another and with the Doncaster railway station.—Lord Jersey said that after the decision of the Board of Trade with regard to the Portsmouth case, the Commissioners could not approve of the proposal of the Corporation to cross the Marshgate level crossing. With that understanding the Commissioners considered the preamble of the Bill proven.

Dudley and Wolverhampton.—The Birmingham press contains official notice of the application shortly to be made to the Board of Trade for the transfer of the Dudley and Wolverhampton Tramways Company's undertaking to the British Electric Traction Company.

Dundee.—At a meeting of the Tramways Committee last week, the convener reported that his negotiations with the directors of Dundee and District Tramway Company regarding the price to be paid for the plant, which had to be taken over by the Commissioners under the agreement, were not likely to lead to an arrangement. There was no likelihood of the Tramway Company settling the question in an amicable way, and arbitration is to be resorted to. The town clerk has communicated with Mr. Manville, with a view to securing his assistance and advice in electrical traction, and also as regarded the proposed cable tramways. He will visit Dundee and inspect the proposed routes.

Finchley Light Railways.—The Works Committee of the Islington Vestry have received a deputation from the promoters of the Finchley, Hendon and district light railway; one-half a mile of which is proposed to be laid along the Archway Road. Being of opinion that the railway would be of advantage to the parish, the Works Committee recommend the Vestry to approve the principle of the trolley system embodied in the proposed order, so far as relates to the Archway Road, and to authorise them to settle clauses for the protection of the interests of the parish.

Greece.—La Société Electrique de la Mediterranée (Thomson-Houston) has secured a contract to construct an electric tramway between Kalamata and the port of that name, a distance of about two kilometres.

Greenock.—The Parliamentary Bills Committee of the Police Board will oppose the Bill of the Greenock and Port Glasgow Tramways Company, which seeks the sanction of Parliament for the introduction of electrical power on the tramways at Greenock, Port Glasgow, and Gourock.

Huddersfield.—The Tramways Committee has considered a report from the borough engineer on electric tramways construction, equipment, and operation, and recommended that the principle of the report be adopted, and that immediate consideration be given to the advisability of converting the Lindley and Outlane section to electric traction.

Light Railway.—The promoters of the Welshpool Llanfair light railway are meeting with much encouragement. The last schedule of subscriptions to the share capital shows a total of £9,630 subscribed. Only £1,270 remains to be raised; Welshpool Corporation subscribed £4,000.

Liverpool-Prescot.—At the Board of Trade last week Sir Courtenay Boyle heard objections to the confirmation of the order relating to the Liverpool and Prescot Light Electric Railway.

Llandudno.—The Light Railway Commissioners have decided to recommend the provisional order for railway No. 2, as submitted by the Light Railway Company, for the approval of the Board of Trade.

London United Tramways.—It will be remembered that in the last Session of Parliament the London United Tramways Company promoted a Bill which provided, *inter alia*, for the construction of an electric tramway from the terminus of the company's existing lines through Ealing to Hanwell. Mainly owing to the opposition of the Ealing District Council, supported by the Middlesex County Council, the House of Commons Committee vetoed this section of the scheme, but gave the promoters electrical powers for their existing lines, and authorised an extension to Hanwell and Hounslow. The company had in the meantime obtained from the Light Railways Commissioners an order for the construction of a "light railway" from Hanwell to Uxbridge, and applied for another order authorising the construction of a "light railway" from Acton through Ealing to Hanwell. Objections were immediately lodged by the Ealing District Council and the Middlesex County Council on the ground that this was merely a revival of the scheme vetoed by the House of Commons Committee, and that it was not competent for the Light Railways Commissioners to review the decisions of Parliament. The *Daily Chronicle* says that this view has been upheld by the Commissioners. Until Parliamentary powers can be obtained to complete the connection there will be a gap of about two miles in what would otherwise be a through electric tramway from Shepherd's Bush to Uxbridge.

The Metropolitan Railway and Electric Traction.—Replying to a question in the House of Commons on 16th inst., Mr. Ritchie said:—"In 1897 I appointed a committee to inquire into the system of ventilation of the tunnels of the Metropolitan Railway, and the report of the Committee and minutes of evidence were presented to this House in the same year. As recently as December last the managing director of the Metropolitan Railway informed the Board of Trade that the directors of that company, conjointly with the District Company, had secured the services of Sir J. Wolfe Barry and Mr. W. H. Preece, and instructed them to provide the necessary electric plant and appliances for the equipment of a section of the line for experimental working. I hope that these experiments may result in the adoption of some system of electric traction."

Newcastle.—On 15th inst. the City Council had a long debate *re* the merits of the overhead trolley system for Newcastle. The debate was resumed on Tuesday, when the Council approved of the trolley system for the new lines, but undertook that it should not be applied to the central streets pending the opinion of an expert as to their suitability for some other electrical system.

On 20th inst. Mr. Ransome, M.I.C.E., and Mr. Griffiths, of London—met a deputation of Newcastle pressmen at the County Hotel, and in the interests of the Love Electric Traction Company, Limited, explained matters in connection with the conduit system.

(*Continued on page* 303.)

BARCELONA ELECTRIC TRAMWAYS.

The tramways of Barcelona which have been recently equipped for electrical working are owned by an English company having offices at Winchester House, Old Broad Street, London, they may be said to be the city tramways proper of Barcelona. There are other tramways in operation as well, but most of them are minor lines running to the different suburbs.

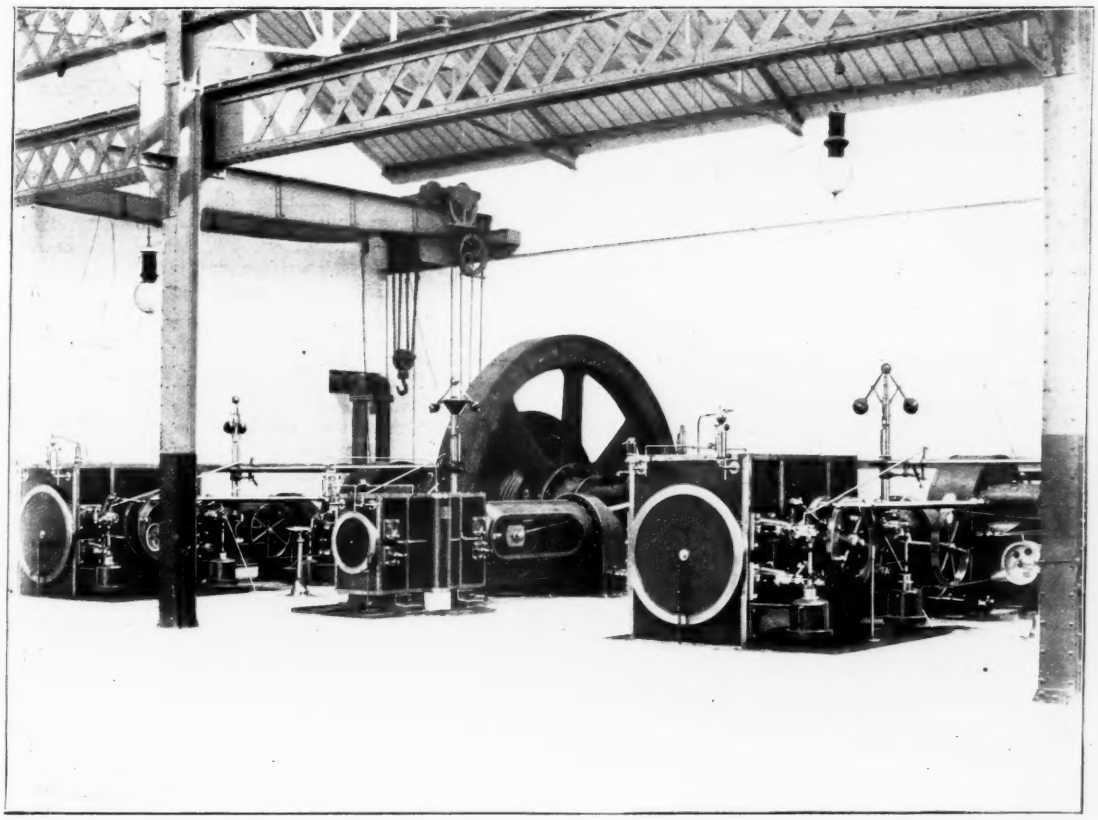
The Barcelona Tramways Company own and work the lines within the heart of the city. They traverse north, south, east and west, reaching northward as far as the important suburb of Gracia, and eastwards to Pueblo Nuevo. The lines have hitherto been worked by horses and mules, the annual mileage reaching close upon two millions. The directors for some time past have recognised the advantages of electric traction, and they took the earliest opportunity of making application for permission to adopt it on their system. After long waiting, they obtained in 1897 a Royal order and permission from the municipal authorities to convert and to work their lines on the overhead system of electric traction.

They immediately invited some 30 firms to tender on the detailed specifications drawn up by their engineers, Messrs. Alfred Dickinson & Co., for the conversion of the lines, and in October, 1897, entered into a contract with Dick, Kerr and Co., Limited, of London, for the complete electrical installation.

The original lines were laid out under the direction of different engineers, and when the conversion from animal to electric traction was commenced, there were no less than seven distinct sections of rails, and the Pueblo Nuevo section of line was of a different gauge from the other portions. In the conversion all the old sections have been abolished with one exception, and the tramways throughout have been laid to a gauge of 1·43 metres (4 feet $8\frac{5}{16}$th inches). The rail used to replace the discarded sections is of the girder type, weighing 83 lbs. per yard.

Each rail joint is double bonded, those at the extreme ends of the line with bonds 4 0 S.W.G., and those nearer the generating station with 6 0 S.W.G. bonds.

The grades are not severe, the heaviest being on the section leading northwards to Gracia. In the relaying of the lines, practically the whole of the junctions have been remodelled, and the local authorities have taken the opportunity of re-arranging many of the levels of their streets, so that the public of Barcelona will derive benefits from the tramway conversion other than that given by the better means of transit.



General View of Power House.

The overhead line is partly centre-pole and partly side-pole construction. The centre-pole construction is extremely neat, a noteworthy feature to which this neatness is largely owing being the use of arms much shorter than in usual practice. In most instances the arms on the poles are not more than 15 inches long. The arms on the side poles vary in length, these lengths having been fixed chiefly with a view to avoiding the cutting of the branches of the trees. This installation very fully illustrates the advantages of the lateral trolley, for, besides enabling the overhead work to be erected in a neat and unobjectionable form, it has permitted the trolley wire to be carried away from the track where the branches of the trees so projected as to prevent the running of a trolley wire on the ordinary system, as in use in the United States.

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The poles are made of mild steel, all in one length, and are of the following dimensions :—Length, 26 feet 6 inches ; diameter at top, 3½ inches; diameter at bottom, 7 inches. They are bedded in concrete to a depth of 6 feet.

The same conditions have been provided for as are laid down by the British Board of Trade for the erection of overhead trolley wires, the line being divided into half-mile lengths by means of section insulators. At each of these points a feeder box is located and current is taken from the feeder cables. Switches are also provided for cutting out sections.

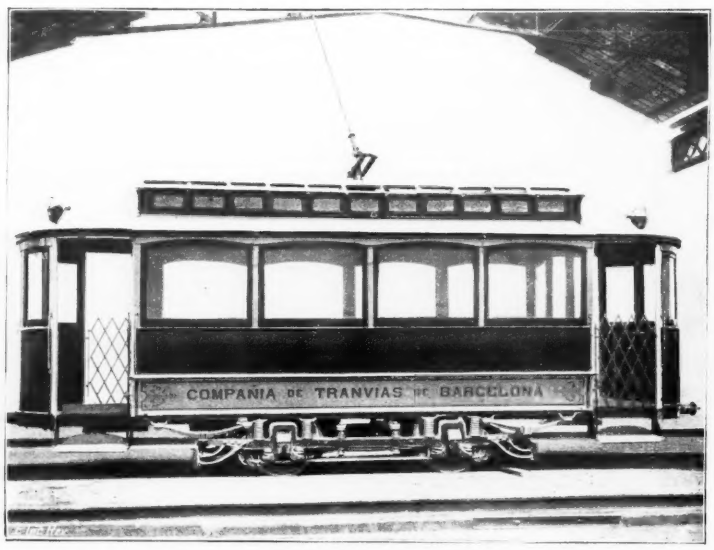
As the object aimed at throughout the system has been to keep the up line trolley wire distinct from the down line trolley wire, so that the disablement of one does not affect the other, it has necessitated the use of specially designed insulated overhead crossings at these places.

Barcelona : A Street View.

The cables from the feeder boxes to the line wire are carried up inside the poles, emerging at the top and running along the bracket arms. The feeder cables are laid in cast-iron troughs, which are filled up with bitumen, and are buried at a depth of 15 inches between the lid of trough and surface of road. The generating station being off the tramway line, it has been necessary to lay return feeders to it from the Marques Del Deuro. These consist of four 37/10 cables, laid in cast-iron troughs and bitumen, in a similar manner to the feeder cables. The whole of the underground work having been carried out by the Callender Company, Limited.

The Power House.

The generating station is almost at the extreme south of the company's system, and 270 yards off the tramway laid in the Marques Del Deuro. No accommodation is provided at this point for the storage of cars nor for the workshops. Very careful consideration had to be given to the question of the most suitable position for the generating station, as owing to the high price of coal it was absolutely necessary to take every means to reduce the fuel consumption to a minimum. As a sufficient supply of water for condensing purposes could not be obtained at either of the sites already owned by the company, the site where the generating station is now erected was specially purchased with a view to reducing the cost of carriage of coal and obtaining a free and ample supply of sea water for condensing purposes.



Barcelona : One of the Cars.

Owing to the fact that this land was but a few years ago reclaimed from the sea, great difficulties were encountered in obtaining suitable foundations. This was only one of the many difficulties met with in connection with this site, for although the main sewer of Barcelona was shown upon the city plans to pass down Carrera, as a matter of fact when the excavations for the foundations were made it was found that the sewer ran through the corner of the land where the generating station was to be built. Some of the difficulties of excavating close to, and some 12 or 13 feet below, a 10-feet sewer which had been built upon mud can readily be imagined. This, coupled with the fact that the water of the Mediterranean had to be contended with, made the construction of the foundations for the generating station no easy task.

The general arrangement of the foundations consists of engine house floor and basement floor. It was originally intended that the basement floor upon which the engine foundations are built should be made of concrete 1 metre thick, but the nature of the site necessitated an increased depth of 4 metres, therefore over the whole area of the engine room there is a block of concrete about 5 metres (16 feet 6 inches) in thickness. The advisability of building the basement floor upon arches was considered, but as the Mediterranean rises to within half a metre of the present basement floor, it was thought more desirable to fill in the whole excavation with concrete.

So treacherous were the foundations that at one time it was considered doubtful whether it would be safe to erect a chimney of 200 feet in height. As at a depth of 9 metres (27 feet 8 inches) the foundations did not appear satisfactory, borings were made with a view to ascertaining to what depth the excavations would have to be made before rock or clay was found. At 17 metres (56 feet) below the bottom of the excavation, the stratification being practically the same as the excavation, it was decided to increase the area of the foundations to about 54 feet square, and make a raft foundation. Accordingly a layer of concrete 4 feet 1 inch in thickness was put in the bottom of the excavation, then a layer of tramway rails 6 inches in section was laid with the rails close together, then a layer of concrete 2 feet 5 inches thick, then another layer of tramway rails laid in the reverse direction, then 2 feet 1 inch of concrete, another layer of rails, 2 feet of concrete, and then 11 feet 6 inches of solid brickwork. The total weight on the foundations was thus reduced to less than 2 tons per superficial foot.

The engine room consists of two bays, one of which is

occupied by the large engines and generators, and the other is partially occupied by the small engines and generators, the remaining space being left for extensions. The whole of the steam and exhaust piping is under the engine room floor, as are the condensers.

The boiler house also consists of two bays running in the reverse direction to the engine house, half of which is occupied by the boilers, pumps and economiser, and the remaining half left for extensions. A more satisfactory arrangement of the engines and boilers could have been made had the site permitted, but, having regard to the future extensions which are contemplated, an arrangement placing the boilers in closer proximity to the engines would have destroyed the site for this purpose.

The boilers are of the Babcock and Wilcox type, each having approximately 3,700 square feet of heating surface, and are each guaranteed to evaporate with ease and with ordinary engine slack at least 12,000 gallons of water per hour under normal conditions. Each boiler is fitted with a deadweight safety valve in addition to spring safety valves and all other modern fittings and devices. In addition to the feed pumps and hot well there is arranged an economiser having 320 tubes.

Barcelona: Laying Feeders.

The large engines are of the cross compound type, the fly-wheel and generator being arranged between the cylinders upon the main shaft of the engine. With a steam pressure of 120 lbs. at the cylinder, and at 90 revolutions per minute, they are guaranteed to give 720 brake horse-power. The high pressure cylinder is 20 inches in diameter, the low pressure cylinder 40 inches in diameter, and the stroke 42 inches. Both high and low pressure cylinders are fitted with Corliss valves. Each engine is provided with a separate surface condenser, which is self-contained, and works quite independently of the main engine. The main steam pipe between the engines and boilers is steel, with wrought-iron flanges, fitted with valves, the frames of which are cast steel. The pipes are arranged to form a complete loop, so that steam can be supplied to one, two, or three engines from either end of the piping, thus minimising the risk of failure through a blown joint in the steam piping. The suction and exhaust pipes to and from the condensers are of cast-iron. The cooling water for the condensers is drawn from a well, which is in direct connection with the Mediterranean, as is shown by the rise and fall of the water within it, an ample supply of water being provided for condensing purposes. After passing through the condensers, it is discharged into the main sewer at the Carrera end of the building.

The two small engines are laid down primarily for lighting the company's extensive car sheds, and for driving the tools in the workshops; but they may also be used for the purpose of boosting, if necessary, or for providing current for a few cars which may be run early in the morning or late at night after the main engines are shut down. The small engines are tandem compound, and at 120 lbs. pressure, and a speed of 350 revolutions are each guaranteed to give 110 brake horse-power.

Running on a gantry over the bay in which the large engines are erected is a travelling crane capable of lifting and traversing longitudinally or transversely a load of 12 tons.

The generators on both the large and small engines are arranged on the main shaft of the engines, and are of the continuous current compound multipolar type. The armatures are of the drum type, and the winding is counterpart with removable and renewable loops. The field magnets are form wound, and can also be easily removed. The brush holders clamp positively the carbon brushes, and can be adjusted in a radial and forward direction and separately in a lateral direction. Each of the large generators are guaranteed to give 900 amperes at 550 volts at 90 revolutions per minute. The small generators are each guaranteed to give 150 amperes at 550 volts at 350 revolutions per minute.

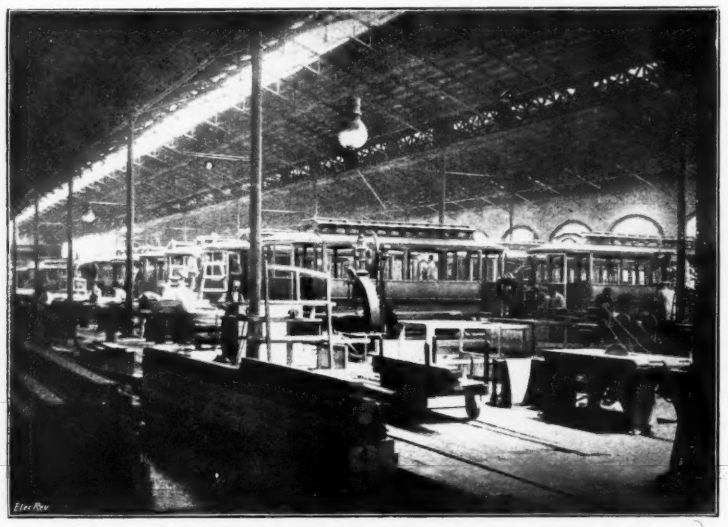
Barcelona: Laying Track.

Barcelona: Laying Feeders.

The switchboard is arranged behind the small engines and generators. This board consists of 15 panels, including a main station panel, three panels for main generators, two for small generators, eight feeder panels, and one testing, or what is known in this country as a Board of Trade panel.

Each generator panel is fitted with a positive and negative

quick-break switch, magnetic circuit breaker, ammeter and voltmeter, and suitable rheostats. The main station panel contains a main ammeter, showing the total output of the station, recording wattmeter, and recording voltmeter. The testing panel is provided with a recording ammeter, recording voltmeter, and a plug board for receiving test wires from different parts of the rails, and all the necessary instruments required by the regulations of the British Board of Trade.

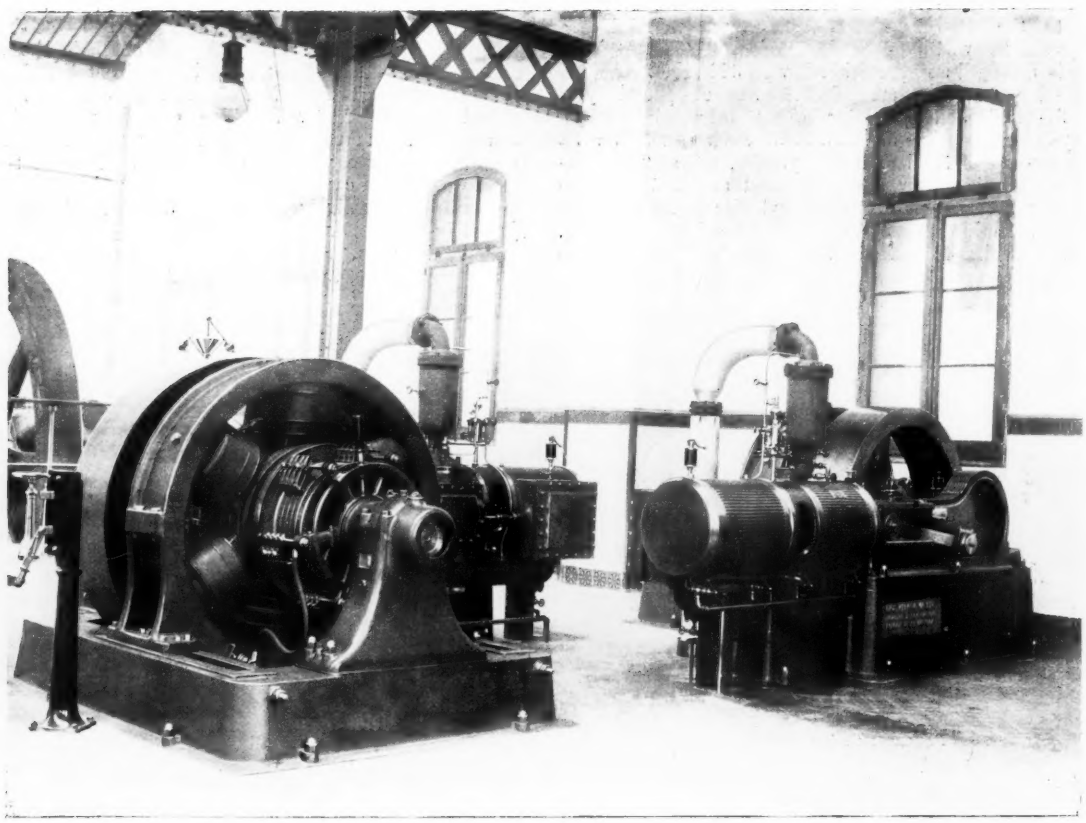


Barcelona: Car Sheds.

Rolling Stock.

The present equipment consists of 85 motor cars, which are generally known as the single-deck type. Their overall length is 25 feet 2 inches, the length inside the body 15 feet 9 inches, and the extreme breadth 6 ft. 11 in. The cars are constructed to carry 44 passengers, 22 seated inside and 22 standing on the platforms. The seats are ranged longitudinally, one on each side of the car. The platforms are enclosed and fitted with sliding windows. The car windows are also arranged to open. There are only four windows in each side of the car, so that when these are lowered the car has very much the appearance of an open car. Owing to the very heavy duty, the contractors arranged to have these cars built in Spain. The result has been highly satisfactory, as both in quality of material, workmanship and finish, the cars are equal either to American or English-built cars.

The car bodies are mounted on trucks of the Brill 21 E type, the frames consisting of one piece, each side being fitted with four coil and two plate springs. The plate springs being fitted at each end, the result is an eminently satisfactory and smooth riding car, free from the pitching so common with four-wheel vehicles. The wheels are 30 inches diameter, having cast steel centres with rolled steel tyres. The tyres are of exceptionally heavy section, so as to provide for the very great wear to which a tramway wheel is subjected. Each wheel is fitted with a cast-iron brake block. These are applied from either end of the car by a brake wheel, arranged vertically, so as to take up the minimum amount of room on the platform.



Barcelona: Lighting and Boosting Plant.

Each car is fitted with two multipolar series wound single reduction motors of the ironclad type, suspended in bearings at the axle end, and by springs attached to a cross-bar at the

opposite end. The cars are driven from either end, each end being fitted with a series parallel controller, which provides for the easy gradation of speed and containing a reversing switch and an emergency switch for short circuiting the motors on themselves to act as an emergency brake. Each car is fitted with an automatic cut-out switch and also a canopy emergency switch, together with the usual equipment of lightning arrester, rheostats, &c. The cars are brilliantly lighted by 10 16-candle-power incandescent lamps, arranged in two series of five lamps each. The car cables are of sufficient sectional area to carry 50 amperes per motor at a density of not exceeding 1,000 amperes per square inch. The insulation is of the highest quality, the specification calling for a total insulation resistance on the car when completed of 10 megohms.

The trolley is of the Dickinson or lateral type, with swivel head.

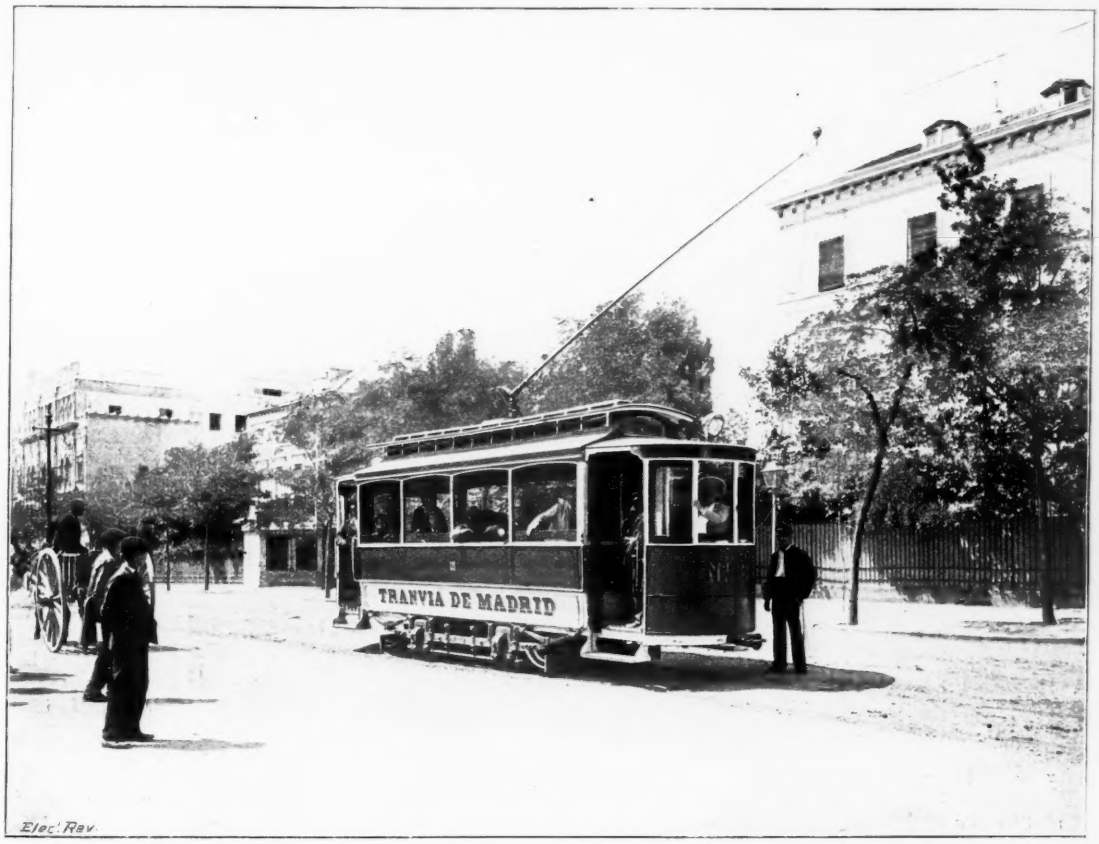
On the introduction of electric traction the directors decided to centralise the car sheds as much as possible, and purchased a piece of land in close proximity to their principal or Calle Borrell depôt, and lying between Calle Borrell and Ronda San Pablo.

Although there is no very severe weather in Barcelona, it is found necessary to run two classes of cars, open cars for summer and closed cars for winter, therefore storage accommodation has to be provided for the summer cars in winter, and *vice versâ* in summer. This has been done by having a special basement floor at this depôt. The cars are run on to a lift and lowered into the basement, where they are placed on the various roads by a traverser. There were many difficulties to be encountered in the construction of this depôt, as at the Ronda San Pablo end there were houses six storeys high, the foundations of which did not go to the depth to which it was necessary to make the excavations to provide the necessary head room for the cars, therefore underpinning had to be resorted to. At the Calle Borrell end of the depôt were some very dilapidated buildings, the foundations of which were really upon rubble. These suffered somewhat by the excavations which were made by the side of them.

A complete suite of offices for the general manager of the company and his staff has been provided in the second storey at the Ronda San Pablo end of the depôt.

MADRID ELECTRIC TRAMWAYS.

There is a good deal of similarity between the tramway systems of Madrid and of Barcelona. The contracts, as a matter of fact, were carried out contemporaneously and under the same auspices and by the same contractors. The owners of the lines are the Tramways Union Company, Limited, an organisation with its headquarters in London. Originally the trams were worked by mules, but the directors becoming impressed with the manifest advantages of electricity, as applied to tramways, called in Messrs. Alfred Dickinson & Co., of Birmingham, who prepared specifications for the complete equipment of the line. Eventually the contract was entrusted to Messrs. Dick, Kerr & Co., for the whole of the generating plant, rolling stock, and street work.

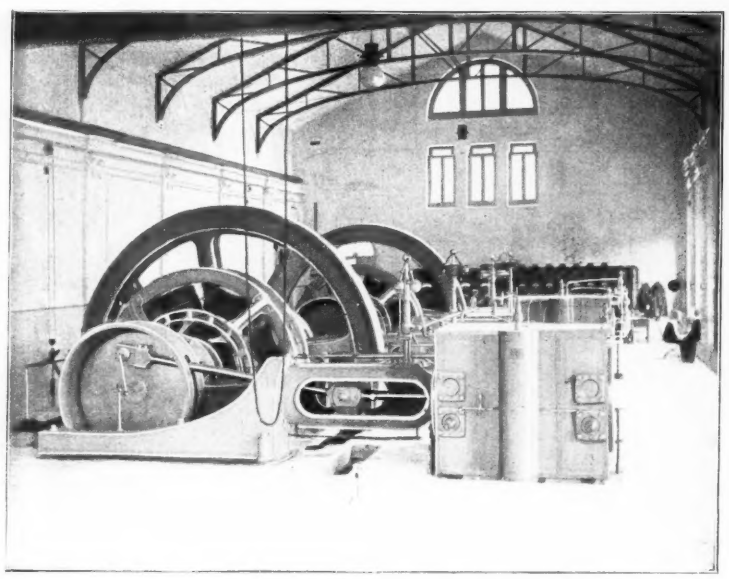


Madrid: Car on Line.

The overhead work is somewhat varied in its character, the wire being carried both on centre and side poles. Mild steel is used in the construction of these poles, and taper from 7 inches at the base to 3½ inches at the top. The arms on the side poles vary in length according to the needs of the different thoroughfares. Generally speaking, the gradients experienced on the Madrid lines are not severe, the worst being 1 in 20; curves are fairly numerous, but these do not call for any special form of overhead construction, the form of trolley pole rendering the passage round the sharpest curves an easy matter. In many thoroughfares the poles are utilised for arc lighting, and are distinctly effective. The total length of line is some 17 miles, the gauge being 4 feet 8½ inches. Throughout the system girder rails have been used, weighing 83 lbs. per yard. They are laid on a concrete foundation, 18 inches wide × 6 inches deep. The rails

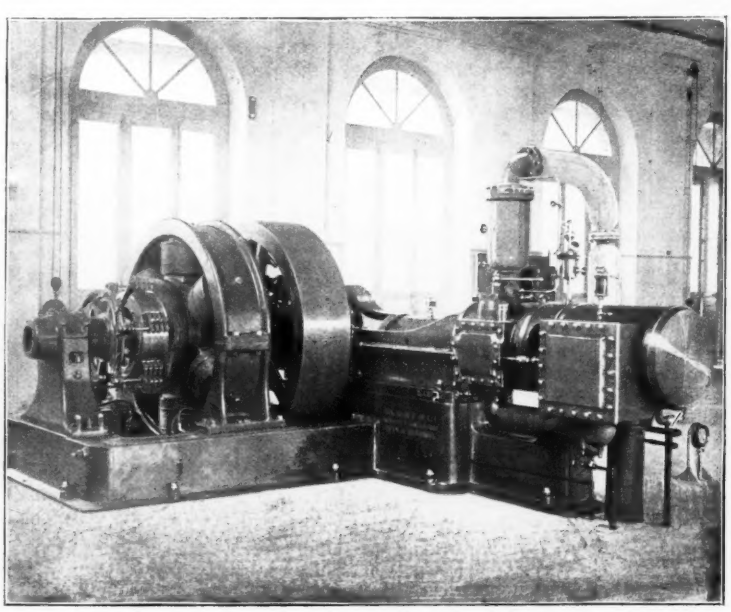
are bonded together by means of Neptune copper bonds of a size varying from 4/0 to 6/0 S.W.G., and 33 inches in length.

The power house is situated near the Calle de San Bernardo and is about 300 yards from the line, though fairly well placed for economical distribution. The generating plant for the tramway consists of two units, the engines being of the compound horizontal condensing type. Each engine develops 720 B.H.P. when running at 90 revolutions per minute, and with a steam pressure of 120 lbs. They are equipped with Corliss automatic valve gear and Reynolds automatic governors, an auxiliary governor is also provided, which is designed to cut off steam when the normal speed is exceeded by 10 per cent. Heavy fly-wheels weighing 24 tons, and 18 feet in diameter, are used, and sight feed lubrication is in vogue. Following the usual American practice, the cylinders of the engine are arranged side by side, and the armature is mounted directly on the main engine shaft.



Madrid: Tramway Generators.

The tramway generators each of 425-kw. capacity, are of the compound wound multipolar type, and work at a pressure of 550 volts. In addition to the tramway plant there is a small lighting set of 75-kw. output, which is mainly employed in lighting the power house and adjoining departments. It is of the multipolar type, compound wound, and designed to deliver current at a pressure of 550 volts. It is coupled direct to a horizontal compound engine, which has a capacity of 110 B.H.P. when running at 350 revolutions. The larger engines, it may be observed, are fitted with a surface condenser of the multitubular type which is capable of condensing 45,000 lbs. of steam per hour. A feature of some importance is that the condensing plant is driven entirely by separate steam plant. The steam raising plant consists of two water-tube boilers, each having 3,654 square feet heating surface, and capable of evaporating 12,000 lbs. of water per hour under normal conditions. In the boiler house are also two compound non-condensing feed pumps, which will deliver 40,000 lbs. of water per hour against a boiler pressure of 125 lbs. There is also the inevitable economiser consisting of 320 tubes. In accordance with commonly-accepted practice, the steam piping is of steel, and is arranged in a ring main. The whole of the piping is carried under the engine room floor thereby improving the appearance of the room. For economical reasons a water tower for cooling the condensing water has been erected, and a fair idea of this will be obtained from the illustration. It consists practically of two steel towers, 24 feet high, and 17 feet × 12 feet. They are placed in the middle of the water storage reservoir, upon a concrete pedestal. The capacity of the reservoir is some 300,000 gallons. Each tower is furnished with two fans, mounted on the same spindle. The fan blades are 9 feet in diameter, and are belt driven by multipolar motors running at 220 revolutions per minute. The fans drive a current of air up inside the towers to meet the heated water which is pumped from the condensers into the tops of the towers, and descends through a series of galvanised iron wire screens into the bottom reservoir, whence it is again passed through the condensers.

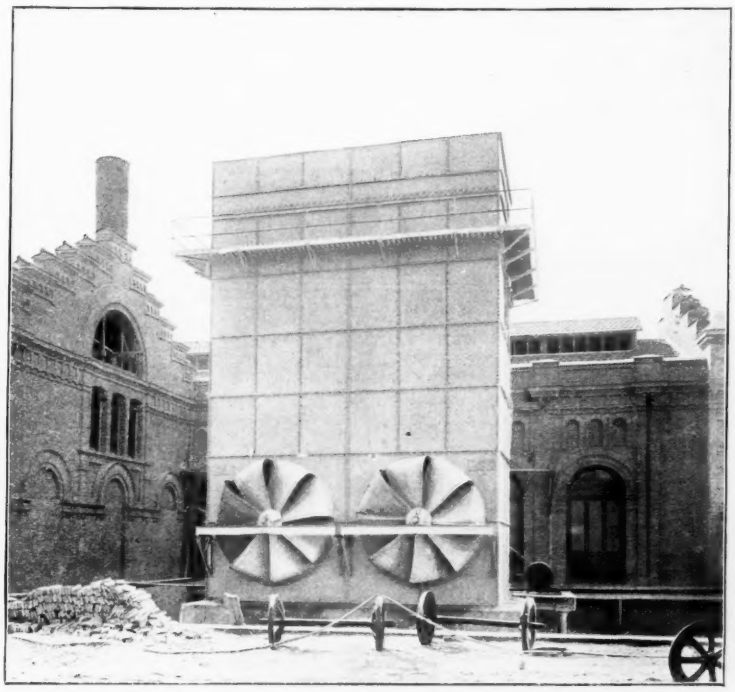


Madrid: View of Lighting Set.

The switchboard is very much after the usual traction type. It consists of 14 panels, and is fixed across the end of the engine room nearest to the boiler house. There are four generator panels (one being spare), each carrying two 1,100-ampere quick-break main switches positive and negative and connected to the positive and negative bus bars respectively. Between each negative switch and bus bar is connected an automatic magnetic circuit breaker with magnetic blow-out. There is also on each panel an ammeter, a shunt rheostat, a resistance switch for breaking the generator field circuits, a lightning arrester, and the necessary plug attachments for putting either of the two main station voltmeters in circuit with any generator. There are seven feeder panels, each carrying an automatic circuit quick-break switch and ammeter similar to those on the generator panels. The main station panel carries the recording instruments, the main station ammeter, &c. The lighting panel carries the circuit switches for the lighting circuits, &c. There is also the usual leakage or testing panel, which is arranged so as to fulfil the conditions as laid down by the British Board of Trade.

Naturally, a system of the magnitude of the Madrid tramways calls for quite an elaborate method of distribution, and feeders have been freely employed. The feeders are composed of Callender's cables and are insulated with vulcanised bitumen, tape yarn and braiding, and are laid in cast-iron troughs filled in with bitumen and buried 3 feet below the surface of the roadway.

The cars are of the single-deck type, and can accommodate 44 passengers, 22 of whom can find seats, and the remainder are compelled to stand. There are 55 motor cars, and they are 15 feet 9 inches in length inside, and 25 feet outside, the wheel base is 6 feet, and diameter of wheels 30 inches.



Madrid: Water Cooling Tower.

The trucks are of the Brill 21 E type, and carry two multipolar motors, series wound, and capable of exerting 15 brake horse-power each continuously without undue rise in temperature. The controllers at each end of the car are of the series parallel type, with interlocking reversing gear and cut-out plugs.

In the reversing switch an arrangement is provided whereby the motors are short circuited through a resistance after the line current is cut off in such a manner that operating the reversing switch converts the motors into generators, causing them to act as emergency brakes in retarding the motion of the car. The lighting of each car is arranged in two groups, each consisting of five 16-candle-power lamps in series. The lateral trolley with swivel head is used throughout.

The chief depôt is at the end of the Calle de Serrano, and here is provided accommodation for 60 cars. At this depôt are the usual plant for repairs and workshops.

We are given to understand that the introduction of the electric lines has given the greatest satisfaction to the authorities and to the public.

Madrid: Section of Field Magnets.

Madrid: Showing Double Arm Brackets.

NOTE ON THE ELECTROLYSIS OF WATER WITH AN ELECTROMOTIVE FORCE LOWER THAN 1·5 VOLT.

By Dr. D. Tommasi.

We know that in order to resolve a molecule of water (H^2O) into its elements, exactly 69 calories must be used, corresponding to an electromotive force of 1·47 volt.

On the other hand, we also know that we can arrive at the decomposition of water, or rather obtain indirectly by the aid of the polarisation of the electrodes, the products of this decomposition, using only excessively weak currents.

It was thus that Flemming was able to record the polarisation of the electrodes of a voltameter containing acidulated water by means of a current, the electromotive force of which was ·008 of a volt.*

Bartoli also arrived at the same result, using, as his source of electricity, a single thermo-electric couple, copper-iron. On heating to the required degree the liquid of the voltameter, Bartoli succeeded in rendering the decomposition visible with the aid of a Daniell element. He was able, in this manner, not only to collect the hydrogen given off, but also to measure its volume.

Moreover, by increasing the sensibility of the voltameter by certain special methods, he succeeded in decomposing

* "On the Polarisation of Electrodes in Water free from Air." *Philosophical Magazine*, Vol. i., p. 148, 1876.

water at the ordinary temperature, and in measuring the volume of hydrogen resulting from this decomposition.*

Bouty, in a paper sent by him to the Physical Society some years ago † showed also that water can be decomposed with the aid of a Regnault couple.‡ The electromotive force of this couple is ·3 volt corresponding to 16 6 calories, and is consequently quite inadequate, according to the electro-chemical theory of the battery, to decompose water.

Sokoloff has proved quite recently,§ by very conclusive experiments, that an electromotive force of about 1 volt (a Daniell element) is sufficient to electrolyse water under ordinary conditions.

Lastly, I have myself shown that, with a single Daniell element, water could be decomposed if we employed as anode a silver wire, although in this case the calories given off by the Daniell element were much less in number than the calories of the decomposition of water, even if we take into account the heat of formation of the oxide of silver.‖ In short, 49 calories < 69 − 7 calories.¶

We find ourselves, therefore, confronted by two facts, both well founded and well established, but yet which seem altogether contradictory; the heat of the decomposition of water on the one hand, and on the other, the electrolysis of this liquid effected with the aid of a current, the electromotive force of which is much lower than 1·47 volt (69 calories).

This phenomenon can be easily explained if we take into account the phenomenon of dissociation. We know, from the splendid researches of H. Deville, that compound bodies, water, for instance, can be decomposed by heat alone, at a temperature much lower than that which they produce when their elements combine, and this decomposition stops as soon as the mixture of the gaseous elements arising from it attains a certain tension called the *tension of dissociation*. Inversely, when we effect the combination of 2 grammes of hydrogen with 16 grammes of oxygen, in order to form a molecule of water (H^2 O), these gases, owing to the high temperature at which their combination is effected, do not unite in an integral manner, but still remain partly dissociated.

Madrid: Street Scene.

It follows, therefore, from what I have just said, that water must always contain, whatever may be the temperature at which one works, a certain quantity of hydrogen and oxygen not combined, but the molecules of which are, nevertheless, sufficiently close to exercise a certain attraction upon one another, which prevents them from separating; it will be easy, therefore, to understand how the decomposition of water has been determined with a current, the electromotive force of which was much lower than that demanded by theory. But, in this case, is it a true decomposition that is effected?

Evidently not, since the current has done no more than simply to separate the small fraction of the elements of the water that were already dissociated in the liquid, and consequently the work effected by the current can be in no way compared to that which it would have been necessary to produce if it really had decomposed the water.

From what I have just said, it follows that in the decomposition of water by the electric current, we have to distinguish two phases; in the first it is the dissociated elements that are carried towards the two electrodes, and in the second it is the products of the decomposition of the water that are given off.

Now, if the electromotive force of the current expressed in calories is less than the heat of the decomposition of water, there will not be any real electrolysis, but only a separation of the dissociated elements; if, on the other hand, the electromotive force of the current is more than 1·47 volt (69 calories), the decomposition of water will take place.

In order to avoid all confusion on this point, I proposed, some years ago, to keep the expression "electrolysis" for any chemical decomposition effected by electricity, and to designate by the name of "*pseudo-electrolysis*" the separation effected, by the current, of merely the products of the dissociation of the electrolyte.*

What I have just said with regard to water applies equally well to the decomposition of saline solutions by the electric current.

Thus, to quote one example only, with a dilute solution of chloride of ammonium we can, with the aid of a current, the electromotive force of which, expressed in calories, is less than the heat of decomposition of this salt, effect a sensible transport of ammonia to the cathode, and of hydrochloric acid to the anode. But in this case, as can be easily seen, it is not a real electrolysis that has been effected, but really a

* "Sulla decomposizione dell 'acqua con una pila di forza elettromotrice assai piu piccola di quella dell' elemento Daniell." *Revista Scientifico Industriale.* Firenze. 1878.

† *Bulletin de la Société de Physique de Paris.*

‡ This element consists of zinc and cadmium, each metal being immersed in its own sulphate.

§ *Annalen der Physik und der Chemie*, von Wiedemann, Vol. lviii., p. 209.

‖ "Cosmos-les-Mondes," p. 638, 1881, and "Traité Théorique et Pratique D'Electro-Chimie," by Dr. D. Tommasi, p. 490.

¶ 49 calories given off by the Daniell element; 69 calories by the decomposition of water; 7 calories by the formation of oxide of silver. (Ag^2 O).

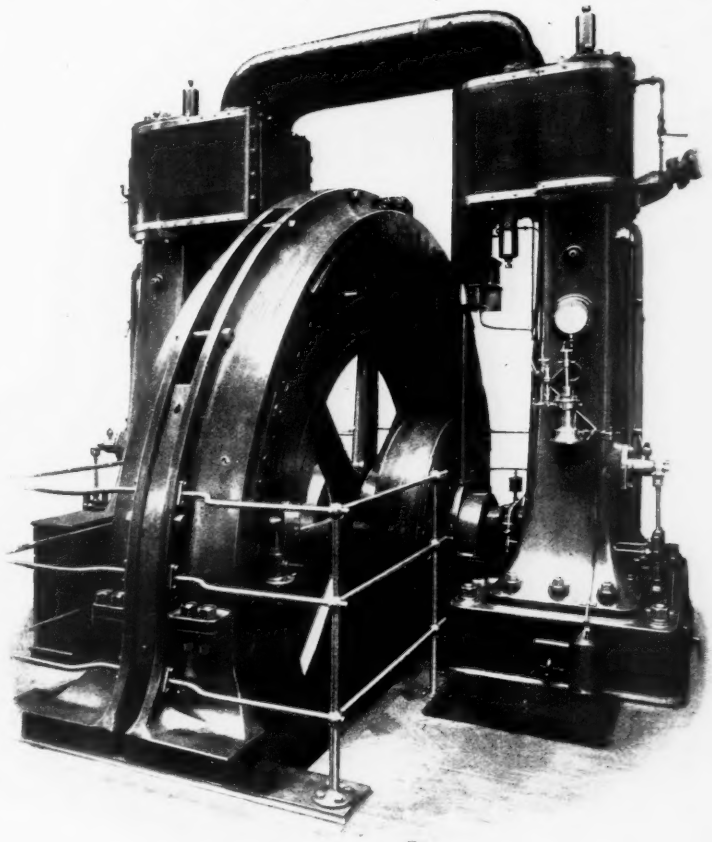
* Dr. D. Tommasi. "Traité Théorique et Pratique D'Electro-Chimie," p. 31.

pseudo-electrolysis, since the current has separated merely the products of dissociation of the dissolved chloride of ammonium. For a true electrolysis to take place, we should have had to use a current, the electromotive force of which, expressed in calories, was higher than the heat of decomposition of the dissolved chloride of ammonium.

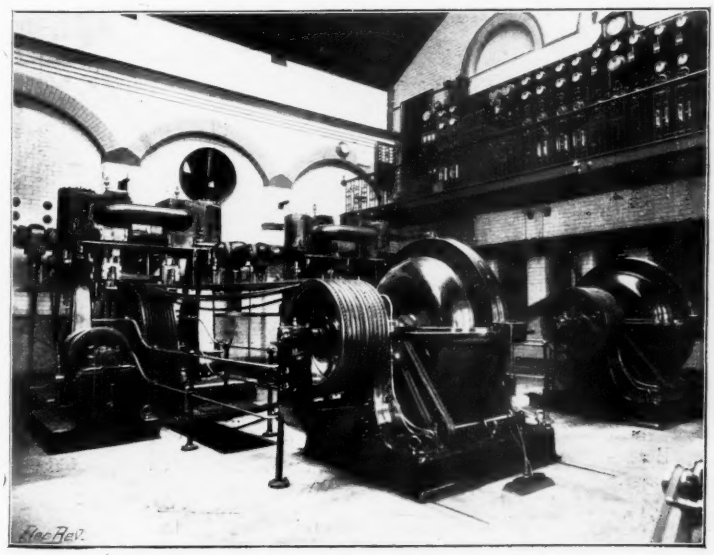
In other words, there is, in my opinion, the same relation between *pseudo-electrolysis* and electrolysis as exists between dissociation and chemical decomposition, properly so called, or between the evaporation of a liquid and its boiling point.

PROGRESS OF THE BOLTON ELECTRICITY WORKS.

It is some four years since we first gave a complete account of the then new works of the Bolton Corporation, but since that period great progress has been made. The present works, which are solely for lighting purposes, consist of the following plant, viz. :—Four 200-kw. Ferranti fly-wheel alternators coupled to four vertical compound engines ; two 100-kw. Mordey-Victoria alternators, rope driven from vertical compound engines ; one motor alternator for battery charging ; two brush exciters coupled to high speed engines ; one battery of 52 cells, 1,500 ampere-hours capacity, the battery being used for exciting purposes and works lighting ; and the usual switchboard. The illustrations afford some indication of the works as they exist at the moment. In the boiler house are six Lancashire boilers, 30 feet long by 7 feet 6 inches diameter, with the usual feed water pumps, feed water heaters, &c. The whole of the existing system is alternating, but during the present year some portions of the town are being changed over to continuous current. At the present time the high pressure current



Bolton : One of the Fly-wheel Alternators.



Bolton : Rope Driven Alternators.

is transmitted to the sub-stations situated in different parts of the central districts.

These chambers are underground, and from them the current is distributed over a three-wire low pressure network with 200 volts across the outers. For the residential districts, where the houses are scattered, house transformers are used, but where there are any number of houses in a small area, sub-stations are put down, 200-volt lamps being used in such cases.

For the portions of the town that are being changed over, Mr. Ellis is laying new low pressure feeders from the generating station to the present sub-stations, where they will be connected up to the present low pressure network. The chief reasons for changing over to continuous current are as follows :—

1. That the present feeders and distributors are fully loaded.
2. On account of the great loss in the transformers.
3. On account of the great demand for motive power ; and,
4. On account of having the tramways driven electrically, the same plant can be used for lighting purposes.

The new feeders will consist of ·8 triple concentric paper insulated lead-covered cables, laid in troughing, and run in with bitumen compound, which makes a solid piece of work.

By changing over to continuous current, it is the intention to use a higher pressure on the distributing network, and instead of having 200 volts across the outers, there will be 460 volts.

This will mean changing consumers' lamps, meters, &c., the lamps being supplied at 230 volts. By changing over, however, the capacity of the low pressure distributing network will be more than doubled, which means a great saving, as well as being able to supply power for private use. As we have previously mentioned in these columns, the Corporation is now equipping their tramways for electrical traction.

A few details of this may be of interest.

There are in all 31 miles of single track or 25 miles of streetage. This will be split up into 10 different routes. The overhead system is being adopted, side brackets being chiefly used. It was shown in our last week's issue that all the tenders for the tramways work have been let. At the commencement there will be 70 motor cars, which are now being made, and the service will be seven minutes, and no doubt the tramways will be in operation by January 1st next.

Extension of Generating Station.

In order to meet the increased demand which there will be on the works in consequence of the tramways the following plant is being erected:—Two 1,000-H.P. sets and two 500-H.P. sets. The generators are being made by Messrs. Mather & Platt, Limited, Manchester, and the engines by Messrs. Musgrave & Sons, Bolton. The generators will be coupled direct on the shafts of the engines, and will be of the multipolar type. The engines will be of the inverted vertical cross compound condensing type with Corliss valves, running at a speed of 100 revolutions per minute. In addition there will be balancing sets for the lighting system and boosters for the tramways system, together with all necessary condensing plant.

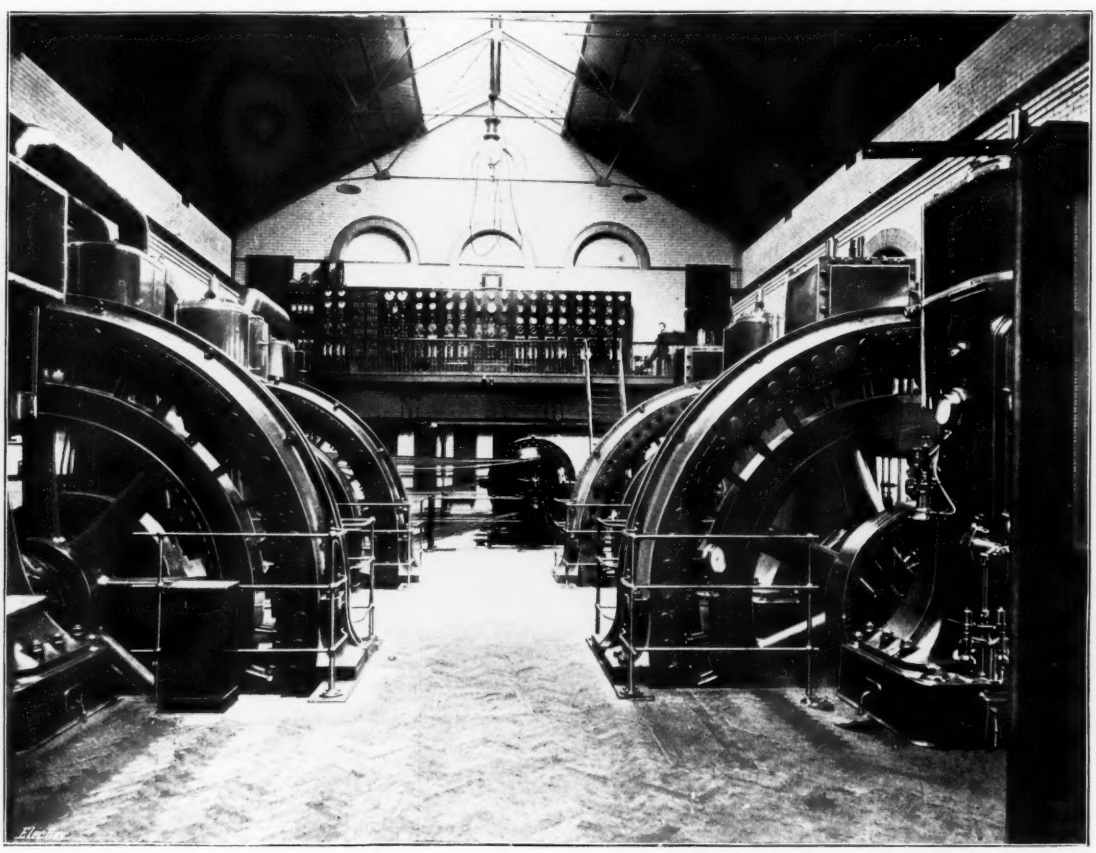
In the boiler house there will be three additional boilers, which will bring up the steam plant to nine. The new boilers will be 30 feet long, and 8 feet in diameter, and will be fitted with mechanical stokers, conveyers, &c. Economisers will also be installed with electrically driven pumps.

As we have already mentioned, the Corporation have recently placed with Messrs. Dick, Kerr & Co., Limited, the complete order for electric motor cars and equipments for their new lines. This order, which is stated to be the largest so far placed by any municipality in Great Britain, covers 70 motor cars with trucks and electrical air-brake equipments. The car bodies are to be built at the works of the Electric Railway and Tramway Carriage Works, Limited, at Preston. They will be of what is known as the improved Preston top-seat type, designed to seat 51 passengers. They will be provided with drop-sashes for the windows, and a number of other small detail departures from existing practice with this type of car, which it is claimed will vastly improve the appearance of the car itself and the comfort of the passengers. The electrical equipment of each car will consist of two 33 S motors of Dick, Kerr & Co.'s standard type, with two solenoidal blow-out controllers and the necessary subsidiary appliances. The trucks will be of the Brill 21 E type, provided with powerful ratchet hand brake. Each of the 70 cars will also be equipped with geared axle-driven air compressors and equipments of the standard type, the same as supplied by Messrs. Dick, Kerr & Co. to the Corporation of Liverpool and the North Staffordshire Tramways.

With regard to the progress made during the past few years, the following items are no doubt of interest:—

Capital Expenditure.

March 25th, 1895	£24,459	14 5	
„ 31st, 1896	34,909	11 1	
1897	44,382	13 7	
1898	57,037	13 7	
1899	68,000	0 0	Estimated.



Bolton: General View of Fly-wheel Alternators.

Sale of Electricity.

Five months to March 25th, 1895 ...	35,128	Sold.
To March 31st, 1896	94,914	„
1897	186,957	„
1898	341,888	„
1899	550,000	Estimated.

Number of Consumers, Lamps, &c., and Price Charged for Current.

—	Number of consumers.	Number of 8-C.P lamps supplied.	Average number of lamps per consumer.	Stat. maximum charge.	Actually charged.
				d.	d
March 25, 1895	65	5,100	78	8	5·4
March 31, 1896	117	9,525	81	8	4·0 to 5·4
1897	237	19,477	82	8	5·0
1898	390	32,000	82	8	4·01
1899	550	44,000	...	...	4

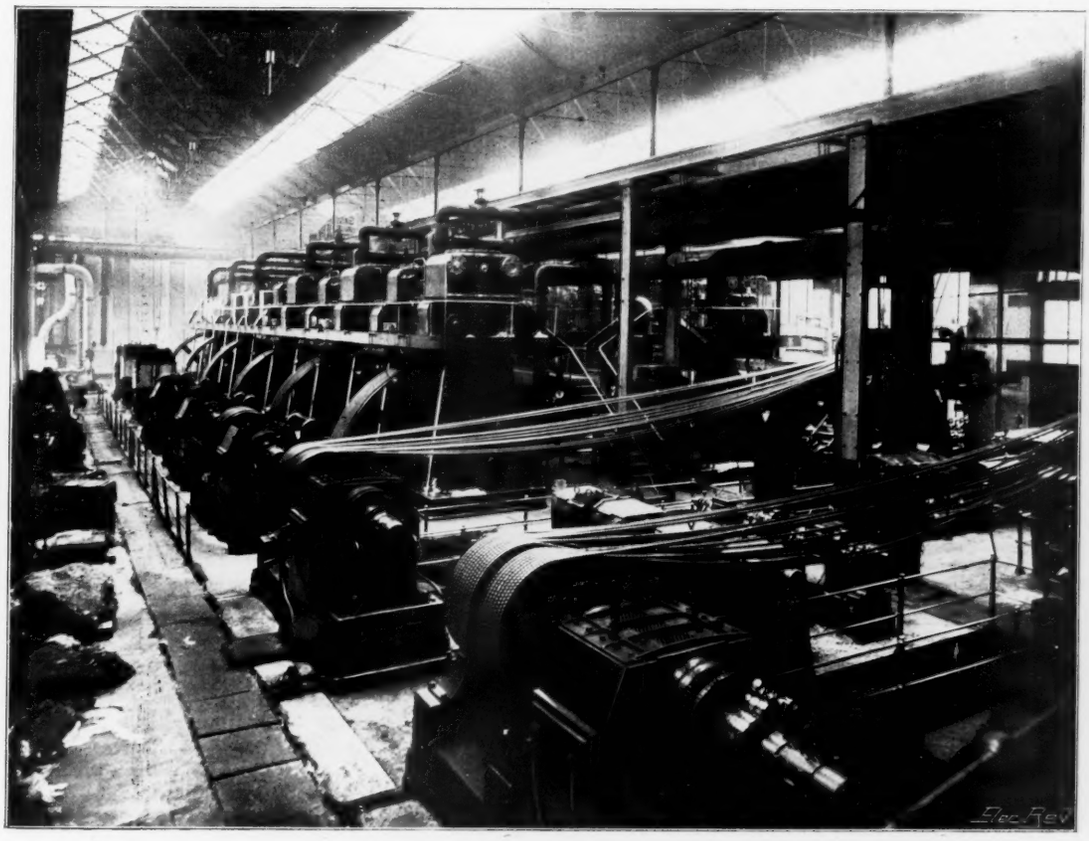
Profit and Loss.

	Net loss carried to reserve fund.	Carried to reserve fund.	Voted in aid of rates.
March 25th, 1895.	£591 17 3	...	...
March 31st, 1896.	1,054 3 6	...	...
1897.	269 18 1	...	...
1898.	...	£917 16 2	...
1899.	Estimated.	1,500 0 0	...

With reference to the number of consumers, lamps, &c., it may be mentioned that the works have been so exceptionally busy during the past few months, that it has been impossible to keep pace with the demand, which increases every day. For the past few months there have never been less than between 30 and 40 applicants waiting to be connected, and during the past few days applications have been received for 150 houses which are being built on one estate. In round numbers there are practically 3,000 lamps applied for, which is sufficient indication of the popularity of electric lighting in Bolton. When the tramways are completed the Bolton Corporation Electricity Works will rank among the most important electrical undertakings in the country. Under the guidance of Mr. Arthur Ellis, the borough electrical engineer, we have no hesitation in saying that the ambitious scheme in progress will achieve great success.

THE MANCHESTER CORPORATION ELECTRICITY WORKS.

The electrical undertaking of the Manchester Corporation has now reached a most interesting stage, for after achieving a most remarkable success in the supply of electricity in the central portions of the city, the authorities are about to carry out a scheme which will not only rank as the largest electricity supply system in the country, but will be in all probability the most conspicuous example of three-phase work in Europe. From time to time we have noted the growth of the Corporation electricity works, and it may be truly said that the builders and contractors were never away from the Dickinson Street station. Leaving for a moment the somewhat colossal scheme to which the municipality is committed, it may be said that the site of the present works is almost utilised to the last inch. When we last gave details of the works, two sets of plant comprising horizontal engines, driving continuous current generators by ropes were nearing completion. These are partly shown in the general view of the works. The output of these units, however, was speedily utilised, and before they had been erected, Mr. Wordingham was preparing schemes which would deal with the needs of Manchester in a full and comprehensive manner. It is hardly necessary to say that the type of plant most commonly employed in the Manchester works is vertical engines, driving generators through the medium of belting.



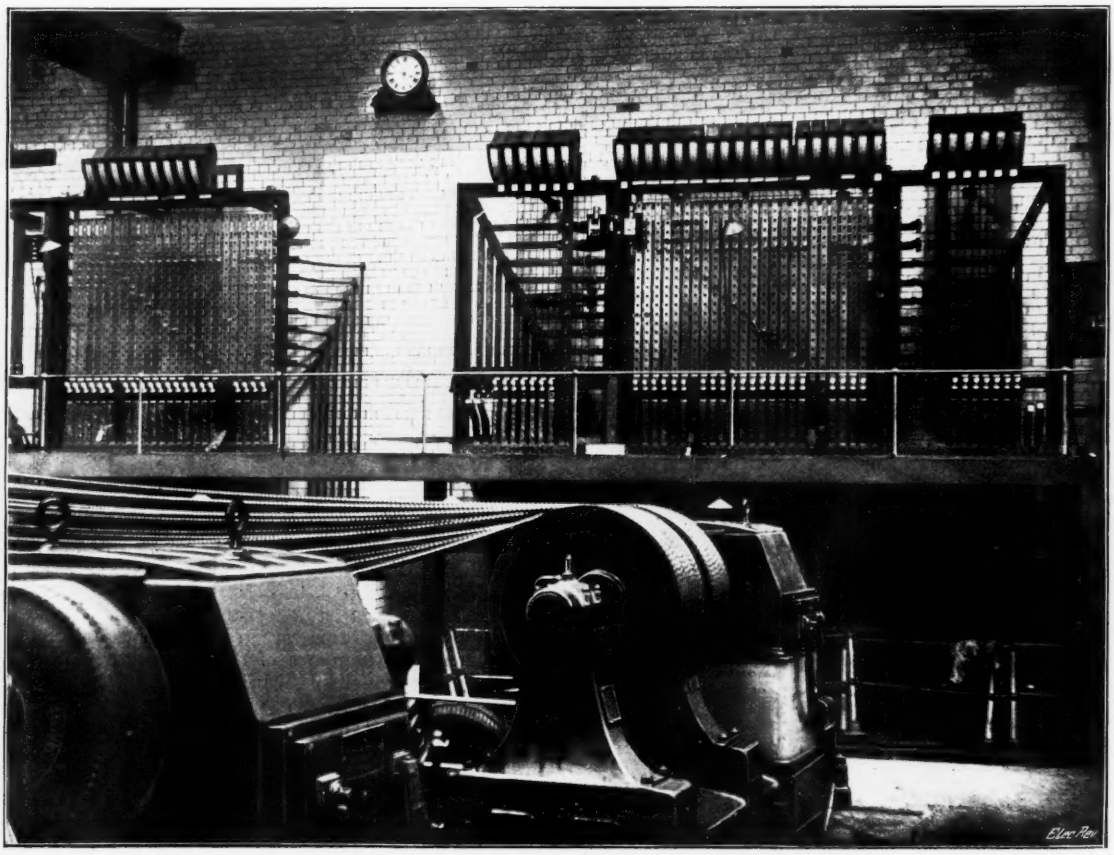
Manchester: General View of Electric Lighting Works.

With the exception of the slight lapse into other methods, evidenced by the two horizontal units, it is not difficult to see that vertical engines are most favoured, and the probability is that much of the future work will be carried out on these lines. The whole output of the present plant is operated and controlled from the switchboard shown in one of the illustrations. There can be no doubt of the simple character of the switching devices, and none as to their incombustible properties. It may be mentioned that two boards control 10,000 horse-power, which merely goes to show that the larger the output the simpler and smaller become the boards. Following the usual Manchester practice, the boards are simply built up of bare metal bars, which are connected to the machines by means of flexible switches shown at the foot of the board, while the feeders are connected by plugs. An interesting main switch, devised by Mr. Wordingham, and used in connection with

the board, is unfortunately not shown in the illustration. It is primarily operated by means of a lever similar to those employed in railway signalling cabins; this brings the switch forward to the contact pieces, and the operation is completed by means of a hand-wheel. It will be understood that somewhat special construction is needed in a mechanism which breaks 2,500 amperes at 400 volts, and it is worthy of mention that this large switch was made at the Corporation works. Underneath the switchboard platform are a series of recording wattmeters, each of which records the output of one machine.

Manchester: Recording Wattmeters For Machines.

There has been lately added to the steam-raising plant four Babcock and Wilcox boilers and six Lancashire boilers. As the exigencies of space have compelled the erection of these at some little distance from the canal, which is contiguous to the works, coal bunkers have been erected into which it will be possible to easily convey coal from the canal, from whence it will fall by gravitation into the hoppers of the Lancashire boilers. In order to carry coal to the water-tube boilers, a special coal conveyer has been erected, which will traverse between the coal bunkers to a position above the boilers. Naturally, the interior of the generating station has been materially altered, and at the end away from the switchboard two of the original units have been removed and a vertical plant of 2,500 H.P. has been erected. The one already in position consists of a vertical compound engine made by Messrs. Musgrove, of Bolton, and between the two cylinders is a continuous current dynamo made by the Electric Construction Company. The armature is built direct on the shaft, and without giving further details of the combination, it may be said that the unit, besides one of the



Manchester: View of Switchboard.

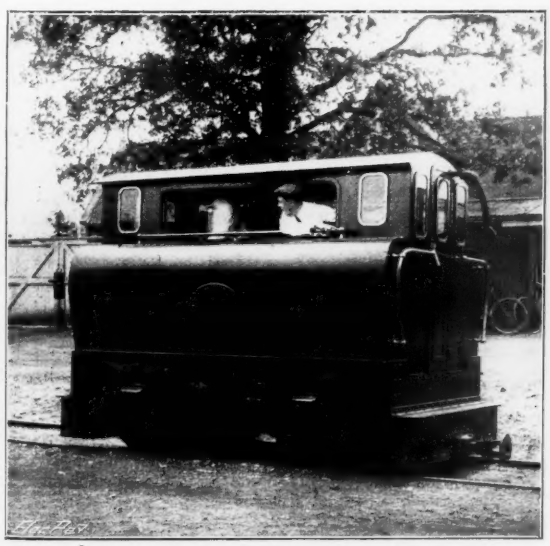
largest in the country, is a magnificent specimen of engine building and dynamo design. A second unit of similar capacity to the foregoing will be erected shortly. This will consist of a vertical engine driving a Siemens dynamo. Another interesting feature will be a three-phase plant of 600 H.P. which will be shortly erected and will be utilised for lighting purposes.

It will be remembered that some time ago the Manchester Corporation decided to embark upon a scheme for lighting the outlying portions of the city and districts controlled by other local authorities. The area to be lighted, and this is likely to be materially added to, covers some 40 miles, and to do this effectually Mr. Wordingham recommended a three-phase transmission with continuous current distribution. In addition to this extensive system of lighting, the municipality is acquiring the whole of the tramways in Manchester, and has decided to equip them for electrical working. It will be understood therefore that the electrical schemes which the Corporation of Manchester is to carry out are of considerable magnitude. We have already reported in these columns that the site for the new three-phase plant has been acquired, and it will not be long before actual work is commenced.

THE LOCOMOTIVES ON THE CITY AND SOUTH LONDON RAILWAY.

This locomotive, illustrated, is similar in general design to those already running on the City and South London Railway, and manufactured by Messrs. Crompton. It consists of a cab and under-frame, as shown, suitable for a 4 feet 8½ inches gauge. The overall height above the rails is 8 feet 5½ inches, extreme width, 6 feet 10 inches, and overall length, from buffer to buffer, 14 feet 2 inches.

The chief points in which this locomotive differs from others, is the fact that the three last locomotives supplied have been fitted with motors suitable for running with series

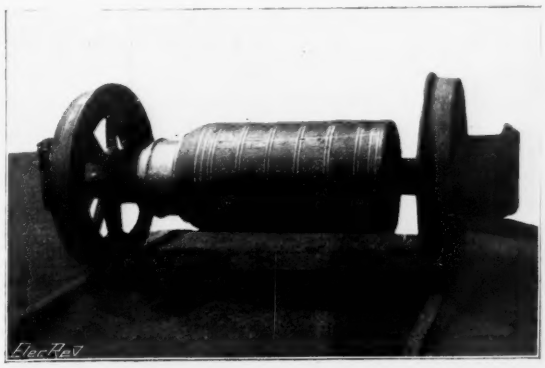


Complete Loco.

parallel controllers. The motors in this particular case consists of four-pole machines with cast-steel magnets bolted in such a way that one half can be removed for inspecting the armatures. The gun-metal brackets supporting the field magnets divide in a similar way. A view is also shown of the armature.

The locomotive is fitted with hand brake and Westinghouse brake, similar in all respects to the locomotives already owned by the company, but in addition there is an air compressor, consisting of a Brotherhood patent air compressor direct coupled to a Crompton enclosed motor. An automatic relay is connected up which starts the air compressor when the pressure in the storage reservoirs falls below a certain point, and stops the motor when the pressure exceeds about 80 lbs.

The armatures are of the ordinary Crompton traction



Armature Mounted on Axle.

pattern, mounted direct on the car axles, the cores being slotted, and the winding being of their well-known "block" pattern.

The locomotive is constructed to draw the ordinary train, consisting of three coaches, but will draw four coaches if necessary. The speed of the locomotive is a good deal

Complete Motor Mounted.

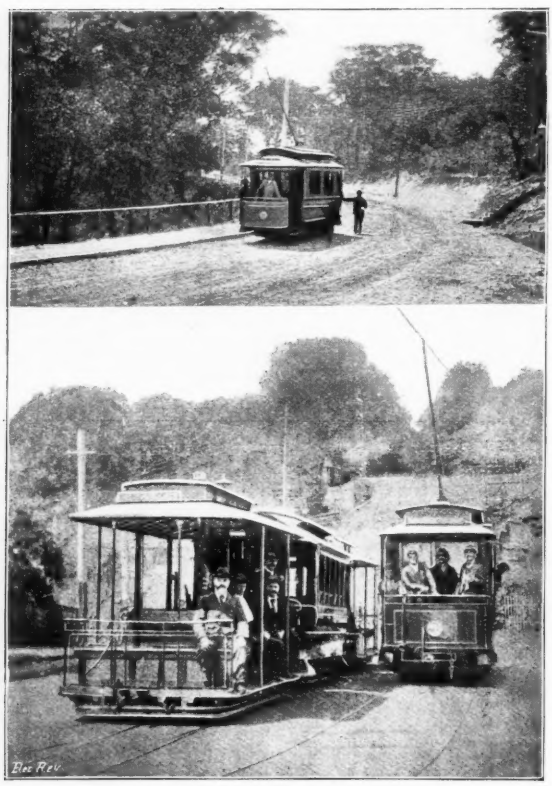
higher than the others on the line. It is obvious that the motors, therefore, are more powerful than those originally employed by the company.

Crompton & Co. have recently received an order for 10 more locomotives similar in most respects to this one, but including certain modifications introduced by Mr. McMahon, the chief engineer to the company.

ELECTRIC TRAMWAYS IN SYDNEY.

The first tram service, says the *Sydney Mail*, started in Sydney about a quarter of a century ago. Then the motive power came from powerful horses, which drew a lumbering car along lines laid from the railway to the northern end of Pitt Street. The inadequacy of this primitive mode of locomotion was evident, and after a brief trial it was abandoned. The steam trams were introduced in 1879, connecting all the populous suburbs with the city. The next system adopted was the cable service, which was first used at North Sydney, and subsequently on the line from the foot of King Street to Ocean Street, Woollahra. A trial of the electric tram on the hills of Mosman, coupled

with the success of that system in America, seems to have satisfied the Railway Commissioners of the superiority of electricity as a motive power. The George and Harris



Two Views on Sydney Tramways.

Street line, now in course of construction, and that at Rose Bay, which opened in October, will both be controlled by electricity, communicated to the cars by means of elevated wires.

The Rose Bay line, which is the subject of the illustrations, takes up the running at the Ocean Street cable tram terminus. The length of the new line is 1 mile 24 chains. The familiar Double Bay Hotel, with the pretty avenue at its side, running down to the shore of the bay, is passed by the tramway. Not far from this we are able to compare two systems, for the cable and electric cars meet near the crown of the steep Double Bay Hill. After leaving the valley the new line winds its way up the ascent on the eastern side of Double Bay. The hills and slopes of Double Bay present enchanting land and sea scapes. One of these is the illustration, taken near Belle Vue Hill. Leaving Double Bay, and approaching Rose Bay, the tram route hugs the shore. A photo of two cars on a trial trip are shown. Another illustration is that of the terminal point of the line, showing the park, the bay, and the young pine trees which hide from view the jetty so well known to Sydney boating men.

Sydney Tramways: View of Rose Bay.

From the Rose Bay line a succession of pleasing panoramas is presented. As passengers hardly ever lose sight of the harbour, the route is bound to be popular. The present population of Double and Rose Bays is not numerous, and consists mostly of well-to-do people. It is therefore not to be expected that the new line will prove immediately remunerative, but when its inevitable extension to South Head comes, there can be little doubt that the trip by tram to Watson's Bay will be as popular with holiday seekers as are the pleasure resorts at Bondi and Coogee.

ELECTRIC CONDUIT SYSTEM.

There is no doubt that since the publication of the figures relating to the working of the New York electric conduit lines the system has received marked attention from English authorities. The most enthusiastic advocate of the overhead system will not deny the extreme practicability of the conduit, the only question is that of expense. It is interesting to illustrate a portion of the New York electric conduit system, which has achieved so signal a success. The view given is that of Lenox Avenue, which was the part first selected by the Metropolitan Street Railway Company of New York. The following facts relating to the introduction of electric conduits in New York, published in a recent number of the *Street Railway Journal*, may be useful :—

"On January 1st, 1893, the entire street railway system of New York City was operated by horses. In the spring of that year the Broadway cable line from Fifty-ninth Street to the Battery, 10·2 (track) miles in length, was put in operation. In 1895 15 (track) miles additional on Columbus, Ninth and Lexington Avenues were opened through streets most of which had previously had no horse railway service, except for a short time preceding the actual starting of the cable lines. Cable construction then stopped and electric began. The company had several times attempted to instal the overhead electric system in the city, but owing to extreme popular prejudice against all overhead wires, due largely to an unusal and indefensible abuse of their privileges by a number of electric light corporations, which had, in previous years, stretched their wires in New York City to such an extent as to be a positive menace to its safety as well as an intolerable eyesore, permission to adopt this system was refused. The importance of doing away with horse traction, in the interests of both the city and the company, became so great, however, that it was at last determined to try the underground conduit electric system, which had previously been a failure in this country wherever installed, owing partly to climatic conditions and partly to an attempt to use too shallow and cheap a conduit. The experiment was first made on the Lenox Avenue line in the northern part of the city, and a conduit was constructed which in point of size and cost was practically equal to that necessary for a cable system, the intention being, should electricity prove a failure, to change to the cable. After some experimenting with insulators, this line proved to be an entire success, and has been steadily and regularly operating ever since, with a rapidly increasing traffic and a quite remarkable economy. Encouraged by this experiment, the company's engineers devised a form of conduit which, while

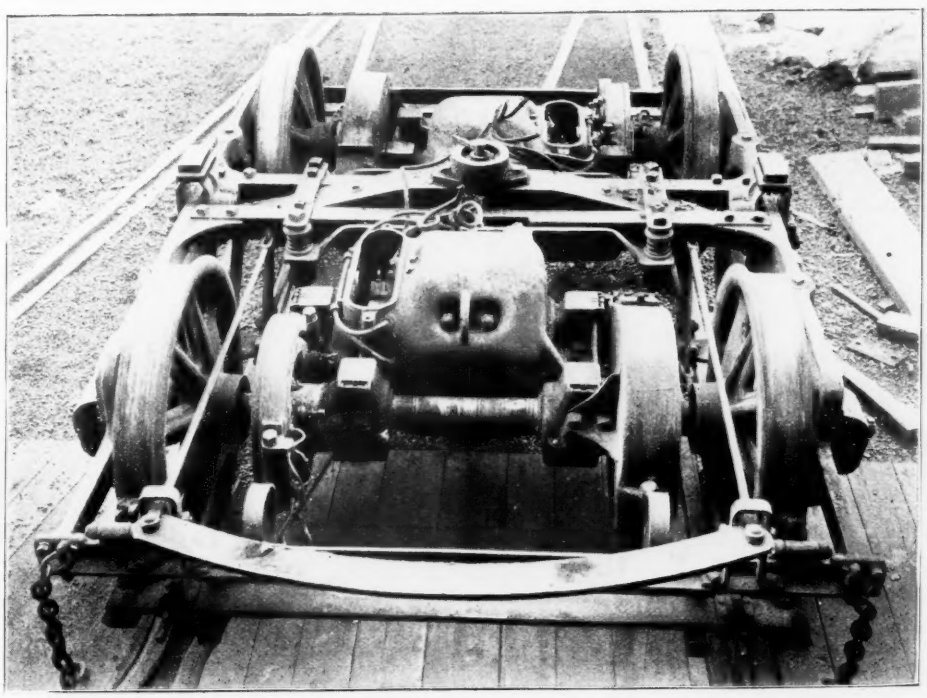
considerably cheaper to build, possessed, it was believed, all the necessary qualifications for success on a large scale, and during the last 15 months nearly 35 miles of double track have been converted from horse to underground electric traction on Second, Madison, Sixth, Eighth and Amsterdam Avenues—all great through north and south routes paralleling the Broadway cable line, and intended to relieve it to a large extent of its enormously congested traffic—and on Fifty-ninth Street." The equipment is of the Thomson-Houston type.

Electric Conduit System.

Plymouth Electric Light and Traction Scheme.—There is every prospect of the Plymouth electricity works being opened before Whitsuntide, and before the summer season one section of the electric tramways will be in operation. Applications for current have come in very atisfactorily, and there is promise of a profitable first year.

ELECTRIC BRAKES FOR TRAMWAYS.

It is hardly necessary to say that the question of brakes on tramcars is of very great importance. Hitherto electric braking has been little used, although any ordinary motor equipment embodies a practical "emergency" brake, which may be applied by short circuiting the motors either directly or through resistance.



Electric Brakes.

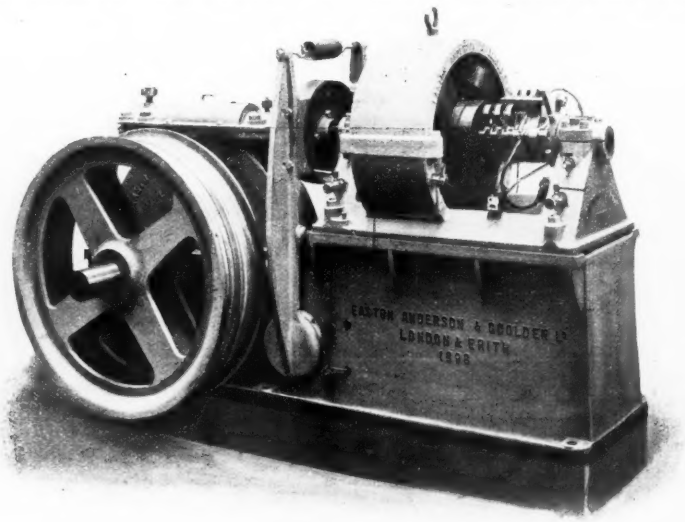
By means, however, of the electric brake proper, a maximum braking effort can be applied, practically instantaneously, by a movement of the same controller handle, as is used for starting and regulating the speed of the car; and the operation is equally effective from the highest to the lowest speeds. This is accomplished by connecting the two motors, by means of the

controller, so that each acts as a generator, the circuit being closed by a resistance, which may be varied by moving the controller-handle. The current thus generated is used to energise a magnet in the form of a disc, mounted on the car axle in such a manner that it cannot revolve, which attracts another disc keyed to the car axle and turning with it, the braking being produced by the resulting friction between the two discs; other purely electrical effects developed also assist to augment the retarding action.

It will be seen, therefore, that the braking power is dependent solely upon the motion of the car, and is in no way derived from the overhead line, so that it makes no difference whether the trolley is on or off the wire. Electric brakes have been made dependent for their action on the current from the trolley wire, but any such system is necessarily imperfect and unsuited to the conditions obtaining in practice. The arrangement and application of the electric brake, as designed and used by the British Thomson-Houston Company, does not in any way interfere with the ordinary hand-brake, and the braking effect being independent of the car wheels, the wear and tear of service does not come upon the wheel treads. As a result of the absence of brake-shoes of any kind on the wheels, the life of the wheels is increased, thus affording a considerable saving in an item next in cost to the electrical maintenance itself.

ELECTRIC LIFTS AT THE NEW BRIGHTON TOWER.

For use in connection with the New Brighton tower, Messrs. Easton, Anderson & Goolden, Limited, of Erith, have recently designed some electric lifts and pumps. The tower, we may remark, consists of a central spire, the base being surrounded by a promenade and theatre and other buildings of considerable height. The height from the ground level to the top of the flagstaff is about 510 feet. The highest gallery accessible to the public is about 480 feet up. The lifts are arranged so as to make the journey up in two stages, the first being to the 80 feet platform, and the second to one situated at 384 feet from the ground, the range of stroke of the lifts in this stage being, therefore, 304 feet. The highest galleries can only be reached by staircase. The passenger lifts to the first or 80 feet stage are two in number, each being designed to carry 12 people, and for a stroke of 80 feet. The speed is 160 feet per minute. They are placed one in each of two opposite corner towers of the building, and their arrangement is very simple.



Lift Motor.

The shaft is a solid masonry well, with three doorways opening to the several floors commanded by the lifts, and the winding gear is placed at the top directly over the well and carried on steel girders. It is of the type patented by the company (Anderson's patent) with a view to getting rid of the many disadvantages connected with the ordinary drum, which are much accentuated in lifts of long stroke such as in this case.

The electric motor, which is of the four-pole type with slotted drum armature wound for 200 volts and provided with carbon brushes, drives a case hardened steel worm situated on the top side of a worm wheel, an arrangement which makes it easy to design the casing so that it is a very simple matter to examine the worm at any time by merely lifting the cover, and is but little trouble to get it out or to take the thrust bearing to pieces. The worm wheel is of phosphor bronze, and drives a horizontal steel shaft having on it a cast-iron drum furnished with eight semi-cylindrical grooves, one side of which plumbs the centre of the cage and the other is nearly over the balance weight.

Underneath this drum and below the supporting joists is fixed a four-grooved pulley by suitable bearing brackets placed on the skew. The four ropes leading up from the cage (each of which is competent by itself to sustain the whole load) are brought over four grooves of the driving drum down to the skewed or cross-over pulley, up again on the other side to the second set of four grooves of the driving drum, and finally down to the balance weight over a smooth faced guide pulley, which in this case is necessary to bring them to the proper position. By this means an excellent grip is obtained of the ropes without the aid of V-shaped grooves, which tend to wear the rope; the ropes always lead off on the same position. The gear is of small dimensions, the size is the same no matter how long the stroke, and any number of ropes may be used to both cage and balance weight without materially increasing the width of the drum.

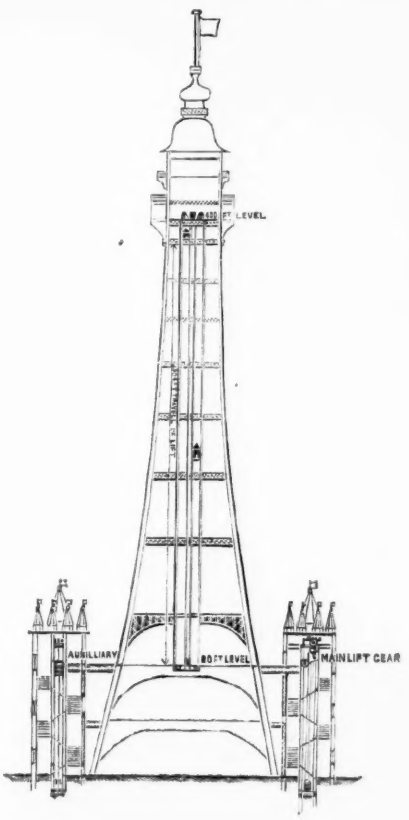
The worm shaft is provided with a powerful magnetic brake acting on a drum on the shaft. The pressure on the brake blocks is given by an adjustable spring, and on starting the lifts the brake magnet is energised, and thus takes off the brake blocks against the spring. The magnet is enclosed on the bed-plate casting, so as to be protected from any damage. The switch is of a simple type, enclosed in a cast-iron casing, and operated by the hand rope in the usual manner. This method is simpler than the automatic devices so frequently adopted, and has the advantage that the speed of the lift may be regulated, a consideration which is often one of some importance, besides which it is less liable to get out of order. No difficulty is found in preventing the lift from being started too quickly, if the switch is properly designed. To avoid any accident arising through the breaking or slipping off of the handrope, emergency switches are fitted, working at each end of the stroke, so that in any case, when the cage reaches the limit of its travel, it cuts the main current off, and so necessarily comes to a speedy standstill, as the cutting off of the current brings the brake promptly into action. The cage is of ornamental woodwork, carried by the company's usual suspension frame and standard safety gear. Both cage and balance weight run on wooden guide rails. The wire rope attachment to the balance weight is made in such a way, that the stress is equally borne by all the four ropes. There is also a goods lift provided in this part of the structure, to work from the ground to the 80-foot level, which is designed to raise a load of 15 cwt. at a speed of 130 feet per minute. It is arranged in a manner precisely similar to the passenger lifts just described, the only difference being that the cage is of a plain type to suit the work this lift has to do. The chief interest of the installation naturally centres in the two main lifts which work in the spire itself, and which take the passengers from the 80 feet level to the 384 feet level or through a stroke of 304 feet. These are constructed to raise from 20 to 25 people, or, say, from 3,000 to 4,000 lbs. each, at a speed of about 300 feet per minute; and owing to the unusual dimensions, position, speed, and length of stroke, are necessarily in many ways special in their design. The chief novelty is, that owing to the fact that the high building at the base of the tower was available for the purpose, the balance weights have been kept out of the spire itself altogether, and are suspended in a masonry well similar to those in which the already described lifts are placed; but inasmuch as the available height is much less than the stroke of the lift, it has been necessary to introduce a multiplying gear with a ratio of four to one, and, of course, a weight four times heavier than that which would be ordinarily required. The stroke, therefore, of the weights is only 76 feet.

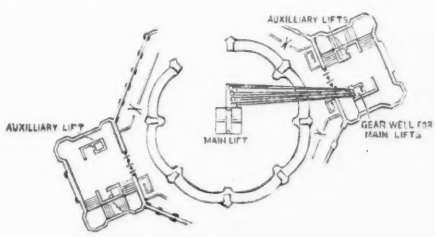
The gearing is exactly the same type as that already described, the advantage of which, with the unusually long stroke, is all the greater. It is, of course, much larger, the work done being about four times as great as in the other lifts, and in some particulars the details are modified on this account. The thrust bearing is separately attached, and is of a different construction, and the pressure of the brake is not given by spring but by a system of levers and a weight.

The four ropes pass up from the balance weight multiplying pulleys over four grooves of the driving drum down over the skewed pulley, up again over the remaining four grooves of the driver down once more to a guide pulley placed a little way down the weight shaft, along horizontally to the lift shafts in the spire, round more guide pulleys and up a trunk at the side of the shafts to the top of the spire, where they lead over pulleys down to two corners of the cage, two ropes thus going to each corner, in which position they can be protected very largely from the effect of the wind, which in such an exposed position is a matter of some consequence. The cages are of a design suited to resist the weather which they necessarily have

to encounter, and are provided with a powerful safety gear. The guides are of wood, and the cages are provided with rollers which run on the guides and cause therefore a minimum of friction, an important matter also on account of the side pressure when a strong wind is blowing.

The switch arrangements are in principle precisely the same as for the lifts already described, only the switches are larger and the hand ropes are of wire, somewhat differently arranged so that they can be more readily controlled by the attendant under the special conditions obtaining. Emergency switches of similar type are also





provided. Space is left in the tower for two more similar lifts to be added at some future time. The lifts have all been at work for some time, and have carried a great number of people.

The water supply of the establishment is provided for by a double bucket bore hole pump, with 6½-inch barrel and 26-inch stroke, drawing from about 55 feet below the surface, and pumping under a total head of 120 feet, driven by means of an electric motor of the same type as those used in the lifts through the medium of worm gearing. As the turning moment is uneven with this type of pump, a heavy fly-wheel is placed on the crankshaft to equalise it to some extent.

The current is supplied to the lifts and pump at 200 volts from a private generating station belonging to the Tower Company.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 286.)

Southampton.—In the Queen's Bench Division of the High Court on Saturday, before Mr. Justice Bruce and Mr. Justice Ridley, judgment was given on a case stated by the arbitrator appointed to decide certain disputes between the Southampton Tramways Company and the Southampton Corporation as to the price at which the Corporation should take over the tramways. The question to be determined, says the *Times*, was whether the company could be compelled to part with the undertaking under the terms of Section 43 of the Tramways Act, 1870. If so, the arbitrator fixed the price to be paid at £51,505, and if not, at £109,963. Their Lordships answered the question in the affirmative, and decided that the award held good for £51,505.

Stockton.—The Imperial Tramway Company have asked the Council whether they would be prepared to enter into negotiations for the supply from the company's works of electric current for lighting this district.

Wolverhampton.—Mr. Emile Garcke presided at a meeting of the Wolverhampton Tramways Company on 14th inst. at Old Jewry Chambers, London. In moving the adoption of the report, &c., he referred to the negotiations which had been going on for over two years with a view to the British Electric Traction Company taking over the whole concern, and an agreement was approved at a former meeting, at which that company undertook to take over the tramways company property at a price which was satisfactory. Unfortunately, the British Electric Traction Company could not arrange with the Wolverhampton Corporation, and that company had to pay the penalty of not carrying out what was a purely provisional agreement. That brought him in touch with the directors of this company, who discussed with him the difficulty, and a scheme was formulated which would make it possible to work the lines. A Bill would be promoted in Parliament to enable the company to alter the gauge of certain of their tramways, and it was proposed to the shareholders that they should sanction a provisional agreement with the British Electric Traction Company to take over the outside portion of the lines at the same price per mile of tramway as the company may receive from the Corporation for the portion within the area. The British Electric Traction Company would promote a Bill at their own expense, and if it did not go through, the tramways company would be no worse off than at present. At an extraordinary general meeting afterwards held, formal resolutions were passed approving of the Bill in Parliament to alter the gauge of certain of the tramways, and also approving the provisional agreement with the British Electric Traction Company.

TELEGRAPH AND TELEPHONE NOTES.

The American Pacific Cable.—A Washington despatch, dated 20th inst., says that the Foreign Relations Committee of the Senate has authorised a favourable report on the amendment to be offered to the Sundry Civil Appropriations Bill providing for the construction of a cable to Hawaii and Manila. The cable is not to be laid by the United States, but the Government will pay a yearly subsidy to the owners.

Indian Telegraphs.—Mr. C. H. Reynolds, Director-General of Indian Telegraphs, has just retired, after 31 years' service. The *Daily News*, in referring to the fact, says that the development of the telegraph in India is a truly wonderful record. There were 13,000 miles of line in 1868, and there are now over 50,000. Thirty years ago 300,000 messages were handed in for dispatch in 12 months, whereas the number in 1898 was only a little short of 6,000,000. The receipts of the department have increased from a comparatively trifling sum to over £1,000,000. Line testing has been introduced, as well as the duplex and quadruplex systems of working. The workshops at head-quarters now turn out the telegraph material on a large scale, so that the country is practically independent of Europe in the matter of supplies, with corresponding saving in expenditure. India possesses probably the longest copper wire in the world, extending from Bengal to Madras, and in connection with this wire some important experiments in long-distance telephoning were made a few years ago. The department has reduced telegraph service in the battle field to a science, and has an excellent record for the work of research and invention.

Inter-Philippines Cable.—The American Government cable steamship *Panama* is expected on this side of the water about a month hence, on her way out to the Philippine Islands with some 170 knots of submarine cable, which has been manufactured in the United States. We understand that the *Panama* is one of the captured Spanish cruisers, we believe that formerly named the *Maria Teresa*. May this activity on the part of the United States Government be taken as indicative of developments in the near future of submarine cable communication between America and the Philippine Islands across the Pacific?

The National Company's Bill.—The *Times* says that objection having been taken to the introduction as a private measure of the Telegraph Act, 1892 (Amendment) Bill, the purpose of which is to enlarge the powers of the National Telephone Company under the provisions of the Telegraph Act, 1892, the first reading stage has been deferred until next Tuesday, when an authoritative ruling upon the subject may be looked for. In view of the decision of Speaker Peel in 1895 with regard to the London Valuation and Assessment Bill—that, inasmuch as it proposed to repeal certain specified Acts, all of which were introduced as public Bills, and further proposed to amend and incorporate the provisions of a Bill, introduced in a previous session as a public Bill, it should be brought in as a public Bill—the opinion is freely expressed that the measure

now awaiting introduction ought to be dealt with in the same fashion, seeing that the main object is to amend Section 5 of the Telegraph Act, 1892.

Proposed German-American Cable.—The *Times* says that the *North-German Gazette* gives great prominence to some remarks of the *New York Herald* on the desirability of a direct cable between Germany and the United States. The *Herald* had said that a cable would contribute to the maintenance of friendly relations between the two Powers, and would promote their commercial intercourse.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	..
New York-Hayti	Feb. 10th, 1899 ...	...
French Company's cables—		
Dakar-Bathurst... ...	Feb. 9th, 1899 ...	...
Paramaribo-Cayenne ...	Feb. 10th, 1899 ...	...
Ceara-Pernambuco	Feb. 19th, 1899 ...	Feb. 21st, 1899
Landlines.		
Lines near La Paz, Bolivia...	Feb. 1st, 1899 ...	...
Indo-European Lines (between Kertsch and Soukhowm Kale)	Feb. 20th, 1899 ...	Feb. 21st, 1899.
Lines North of Japan (between Fukuoka and Moji)	Feb. 17th, 1899 ...	...
Lines near Fao (between Bagdad and Bassora) ...	Feb. 16th, 1899 ...	...

Telegraphs in West Africa.—A *Daily Chronicle* writer says that a remarkable thing which the French have achieved lately in West Africa is the carrying of a telegraph line right across the huge territories of the Niger bend from end to end. Senegal, French Soudan, French Guinea, the Ivory Coast, and Dahomey are now in telegraphic communication with one another.

The Telephone Question.—In the House of Commons on Monday, Mr. Provand asked the Secretary to the Treasury whether the Government intended to adopt the suggestion of the Select Committee on Telephones of last year, and, following the precedent of the Electric Lighting Act of 1882, pass into law a general Act under which local authorities could, by obtaining provisional orders, secure the right to establish telephone service in their own telephone areas. —Mr. Hanbury: Yes, sir, the Government intend shortly to introduce a Bill based on the recommendations of the Committee of last year.

The Shrewsbury Town Council will use every endeavour to get the Bills of the National Telephone Company thrown out on second reading, and to impress upon the Government the necessity for immediate steps to cheapen and develop the telephone service.

The Paddington Vestry and an additional number of local authorities in different parts of the country have decided during the past few days to oppose the National Telephone Company's Bills.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—March 16th. The Electric Committee wants tenders for switchboard extensions. See our "Official Notices" this week.

Brighton.—March 6th. Tenders are invited by the Council for a 20-ton travelling crane for the electricity works. See this week's "Official Notices."

Canterbury.—March 14th. Tenders are wanted for boiler house plant, engine house plant, extensions of switchboard and mains. See our "Official Notices" February 17th.

Christiania.—February 26th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania, stating that tenders are invited by the Norwegian State Telegraph Administration for the delivery of about 140,400 porcelain telegraph and telephone insulators. Tenders must be received at Christiania by 12 o'clock noon on February 26th, 1899. A copy of the specification, conditions, &c., may be examined on personal application at the Commercial Department of the Foreign Office any day, between the hours of 11 a.m. and 5 p.m.

Dublin.—February 24th. The Corporation wants tenders for the supply of about 8,000 200-volt lamps. See our "Official Notices" February 17th.

Dundee.—March 15th. The Gas Commissioners are inviting tenders for four Lancashire boilers, two 450-H.P. steam engines and dynamos, and one 700-H.P. steam engine and dynamo. Particulars from the electrical engineer, Mr. W. H. Tittensor. See our "Official Notices" February 17th.

Edinburgh.—February 27th. The Council wants tenders for steam, exhaust, feed, and drain pipes, feed pumps and tanks. See our "Official Notices" February 10th.

Edinburgh.—March 6th. Tenders are wanted for condensing plant with water cooling tower, feed water tanks and filters for the electricity works. The Corporation also wants tenders for electric lighting installation at Tollcross tramway power station. See our "Official Notices" February 17th for particulars of both contracts.

France.—February 28th. Tenders are being invited by the French post and telegraph authorities in Paris for the supply of 10,000 metres of iron pipes, 65 mm. diameter, for pneumatic pipe lines. Tenders to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Greenock.—March 3rd. The Police Board wants tenders for the supply and erection of boiler-house plant, engine-house plant, and overhead travelling crane for their electric works (low tension). See our "Official Notices" February 17th.

Hammersmith.—March 15th. The Vestry invites tenders for water-tube boilers, 1,000-H.P. slow speed engines, and two 60-kw. alternators, feeders, and cast-iron pipes. See "Official Notices" this week.

Huddersfield.—February 27th. The Electricity Committee wants tenders for mechanical coking stokers, also for a complete switchboard. See our "Official Notices" February 17th.

Italy.—February 25th. Tenders are being invited by the municipal authorities of San Severa (Province of Foggia), for the electric lighting of the town. Tenders are to be sent to Il Municipio di San Severa (Foggia), Italy, from whence particulars may be obtained.

Lewes.—March 24th. The Corporation is prepared to receive offers from those willing to establish an electricity supply undertaking. See our "Official Notices" February 17th.

London.—The Asylums Committee of the London County Council invites tenders for the supply of electric light sundries to the Claybury and Heath Lunatic Asylums for one year from April 1st. Particulars obtainable at the Committee's offices, 6, Waterloo Place, S.W.

Oystermouth.—February 27th. The District Council wants tenders for the supply of electricity within the area. See our "Official Notices" February 3rd.

Pernambuco.—March 18th. The Government of the State of Pernambuco invites tenders for the construction of an electric tramway to run between that city and Olinda, situated at about three miles distance. Tenders, duly sealed, must be addressed to the "Secretaria da Industria," Pernambuco, and should be received there not later than March 18th. Further particulars may be obtained on application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Poplar.—The Guardians wants tenders for steam turbines and dynamos (direct coupled), electric motors, accumulators, cables, wiring and fittings, distribution, and switchboards. See our "Official Notices" this week.

Redditch.—February 27th. The District Council wants tenders for the supply of about 100 alternating current meters. See our "Official Notices" February 17th.

Sheffield.—February 27th. Tenders are being invited by the Ecclesall Bierlow Union Guardians for an electric light plant for their workhouse, The Edge, Sheffield. Particulars from the architect, Mr. Webster, 19, St. James Street, Sheffield.

Shoreditch.—February 28th. Tenders are invited by the Vestry for the supply for one year of electric cables, wiring and fittings, and engineers' stores. Forms on which to tender, and particulars, may be obtained from the Town Hall. See our "Official Notices" this week.

Spain.—March 16th. Tenders are being invited until March 16th by the municipal authorities of Betanzos, for the concession for the electric lighting of the public streets. Tenders are to be sent to El Secretario del Ayuntamiento de Betanzos, Spain, whence particulars may be obtained.

Stockport.—March 9th. The Gas and Electricity Committee invites tenders for two 140-kw. shunt wound dynamos. See "Official Notices" this week.

Stockport.—March 24th. Tenders for electric lighting the Stockport Sunday School, the largest institution of its kind in the world, are invited to be sent in to the Secretary not later than March 24th.

CLOSED.

Bury.—The Electric Lighting Committee reports having accepted the following tenders:—Messrs. Davey & Co., for boiler plant, £1,495; Messrs. Fowler & Co., for engine house plant, £5,793; the Callender's Cable and Construction Company, for mains, £2,994; Messrs. Grimwood & Sons, for buildings, £3,470. The works will be pushed forward, in the hope that the electric lighting may be inaugurated before the year of office of the present Mayor is completed.

Buxton.—The *Contract Journal* says that the District Council has accepted the tender of Callender's Cable and Construction Company for feeders, mains, and arc light leads. Tenders were also submitted by Messrs. W. T. Henley's Telegraph Works Company, Limited; British Insulated Wire Company, Limited; Western Electric Company; Siemens Bros. & Co, Limited; W. J. Glover and Co., St. Helens, Lancs.

Glasgow.—The Electricity Committee have accepted the following tenders for engines, dynamos, and condensing plant for Port Dundas and Pollokshaws Road stations:—Messrs. Mavor and Coulson, two 200-horse-power engines and dynamos, with one spare armature, £2,629; Messrs. the Mirrlees, Watson & Yaryan Company, one 400-horse-power engine and dynamo, with one spare armature, £2,565; Messrs. Crompton & Co., Limited, one 400-horse-power engine and dynamo, and one spare armature for one of the 200-horse-power dynamos, £2,601; the British Thomson-Houston Company, Limited, two 1,100-horse-power engines and dynamos, £14,278; Messrs. Crompton & Co., Limited, two 1,100-horse-power engines and dynamos, £14,780.

King's Lynn.—It is stated by an exchange that the tender of Messrs. Spagnoletti & Crookes has been accepted for wiring the various public buildings in the borough for the Council, and that of Messrs. Siemens Bros., for erecting lamps for street lighting for £1,960.

London.—The London County Council on Tuesday received a report from the Highways Committee in reference to the tenders opened on the 31st ult. for the supply of dynamos and switchboards and gas engines for the electric lighting of the Victoria Embankment and Westminster Bridge. The committee stated that they were informed that the rates of wages and hours of labour shown in the respective schedules attached to the tenders of Messrs. McClure & Whitfield, of Stockport, and Messrs J. E. H. Andrew and Co., of Reddish, near Stockport, are those prevailing in the district in which their works are situated. The committee recommended the acceptance of the tenders of these two firms at £3,726 5s. and £1,900 for the dynamos and gas engines respectively, and this was adopted. The complete list of tenders appeared in our issue of the 3rd inst.

FORTHCOMING EVENTS.

Friday, February 24th.—At 5 p.m. Physical Society. Agenda:—"The Joule-Thomson Thermal Effect," by E. F. J. Love, M.A.; "A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids," by Albert Griffiths, M.Sc.; "Note on the Source of Energy in Diffusive Convection," by Albert Griffiths, M.Sc.

Wednesday, March 1st.—At 7.30 p.m. The Institution of Electrical Engineers. Institution of Electrical Engineer's Students' meeting. Paper on "Direct and Alternate Current Distribution," by H. H. Williams, student.

Thursday, March 2nd.—At 8 p.m. The Institution of Electrical Engineers. "Wireless Telegraphy," by G. Marconi, member.

Friday, March 3rd.—At 8 p.m. The Institution of Junior Engineers, Westminster Palace Hotel. Paper on "Carbon Consuming Batteries and their Possibilities," by W. R. Cooper, B.Sc. M.I.J.E., illustrated by experiments.

Saturday, March 4th.—The Institution of Electrical Engineers. Students' visit to the works of Messrs. Easton, Anderson and Goolden, Erith. Train leaves Charing Cross at 10 a.m.

NOTES.

The Nernst Electric Lamp.—We stated in our short notice of last week, relative to the German reports upon the prospects of the Nernst lamp, that it was intended to float a company in this country for purchase of the English patent rights. We now present our readers with further details of the proposed company, taken from an article which appeared in the *Financial News* of last Monday. This article was headed "The Nernst Electric Lamp, an Invention to do for Electricity what the Welsbach did for Gas," a title which is eminently calculated to cause a "boom" in the Nernst lamp shares. We dislike "booms" of all kinds, even when there is a real and serviceable invention behind them. The capital of the new company is to be £320,000; divided into £140,000 7 per cent. non-cumulative preference shares, and £180,000 ordinary shares. £115,000 ordinary shares are to be offered for public subscription. The company is to pay £270,000 in cash and shares (£65,000 in cash) for the patent rights in the United Kingdom, and certain specified colonies and dependencies. The board of the new company will consist of Sir Henry Mance, Dr. W. Nernst, Mr. B. M. Drake, Mr. G. G. Fort, and Mr. B. Tusman, and Mr. James Swinburne is to be appointed consulting engineer.

American Arc Carbon Makers Amalgamate.—According to the New York journals, the National Carbon Company was recently formed at New Jersey, with $10,000,000 capital, to control the electric carbon industry in America. An already existing combination takes in a number of previously independent companies. It is held that carbons have been sold too cheaply, but prices may now be expected to improve, although the economies in management, resulting from the amalgamation, may render this unnecessary. It has been estimated that during the past 15 years some 75 carbon factories have been started in America and in Europe, with a capacity reaching 600,000,000 of carbons a year. It is doubted whether the consumption exceeds half that. The American factories which have gone into this consolidation, and which will naturally try to control the trade for the present in this country, have, it may be figured, a capacity of 450,000,000 a year, so that even a large growth of arc lighting can be taken care of very comfortably, without expenditure to increase capacity, while the hand processes of manufacture, which once numbered 30 or 40, are already a bare half-dozen.

Yellow Journalese.—It is said that Keats was killed by an article in the *Saturday Review*. Possibly it was the spirit of the article rather than its intelligence which proved too much for the poet. Some of the writers in our columns are made of tougher stuff than poor Keats, and do not seem to come to much harm, even from repeated strokes of *Lightning*. Possibly, the potential is small, and the will to be cleverly spiteful is not backed by the ability. When self-appointed masters of style, however, take it on themselves to lay down the law they ought to be very careful as to details. First, they should be sure of their facts; secondly, they should not make the mistake of writing *firstly*, and finally they should study the history of the metrical system and its suppositious values.

Telegraphists' School of Science.—On Monday the Duke of Norfolk presented, at the St. Martin's Town Hall, the medals and certificates gained during the past year by the students of the Telegraphists' School of Science of the Central Telegraph Office. The chairman, Mr. A. Brooker, chief instructor of the school, stated that during the past year the students had beaten all previous records in the matter of successes. Their meeting marked the closing of the school so far as the Central Telegraph Office was concerned, but the classes would be continued in more spacious premises at the Northampton Institute, Clerkenwell. After the distribution of the awards, says the *Times*, the Postmaster-General presented Mr. W. Slingo, founder and for 21 years principal of the school, with a service of plate subscribed for by the male students on the occasion of his retirement as a mark of their affection and esteem. Mr. Slingo, in acknowledging the gift, mentioned that the school, which was started at a time when technical education was seldom spoken of, began with five students, whereas last year the number on the roll exceeded 800.

Personal.—We are very sorry to hear that Mr. Philip Dawson, who was to have read a paper on "Electric Traction and its Application to Railway Work," at the Society of Arts meeting on Wednesday last, has been very ill with a severe attack of influenza. We are pleased to hear that he is now getting about again, and we hope ere long he may be quite restored to his usual good health.

Mr. R. E. Crompton left on Wednesday morning for Calcutta. He goes overland to Marseilles, and there joins ss. *Arabia* for Bombay. He is proceeding to Calcutta in the interests of both Crompton & Co., Limited, and the Calcutta Electric Supply Corporation. The lighting station is progressing rapidly, and the supply of current will shortly commence.

The Postmaster-General has appointed Mr. J. Gavey to be assistant engineer-in-chief and electrician to the Post Office, in place of Mr. J. Hookey, who is now engineer-in-chief.

The Charge of Breaking Up Roads at Battersea.—At the South-Western Police-court on Thursday last week Mr. Lane, Q.C., heard the adjourned summons against the County of London Brush Electric Lighting Company for breaking up and opening the pavement of Trinity Road, Wandsworth Common, without having previously given notice in writing to the Battersea Vestry. The circumstances have been already reported in the Review in connection with the High Court application. The magistrate, according to the *Times*, imposed a penalty of £2, with £2 2s. costs.

French Smoke Prevention.—The report of the Paris Commission on smoke prevention states that the duty of the Commission was the selection of acceptable forms of furnaces, and the number of competitors was 110, mostly based on some well-known system including smoke washing. Three-fourths were French, one-fifth were English, and there were three American furnaces or devices. Each appliance was tested with both quick and slow combustion, and by men supplied by the makers but firemen supplied by the Commission. The German Commission in calculating heating powers from analysis used the formula—

$$8{,}000\ C + 29{,}000\ (H - O/8) + 2{,}500\ S - 600\ W$$

where W is water. This German Commission of 1892 decided that success had not been attained, though its direction had been indicated. The Paris Commission did practically the same, for they have given no first prize, two seconds, two first mentions, one second mention. The Commission has concluded that smoke cannot be suppressed without considerable excess of cost. The chimney top should be visible to the fireman. Any apparatus in view should be put under more prolonged tests for durability. These conclusions are not very satisfactory, perhaps, and we do not quite agree that prevention of smoke entails necessarily *considerable* extra cost while it has been accomplished with economy.

Postal Telegraph Progress in 1898.—The report of the Postmaster-General states that the extension of the telephone trunk lines has been proceeding apace during the year. In January extensions took place to Banbury, Banff, Elgin, Inverness, Peterhead, Rugby, and Ware; in February to Pentre (South Wales), Spennymoor, Cromer, Buckie, and Newmarket; in April to Coldstream; in May to Weybridge; in June to Hereford and Bradford-on-Avon; in July to Cowbridge; in August to Wexford, Waterford, and Market Harborough; in December to Duncon, Rothesay, and Nairn. Simultaneously with these extensions there have been a number of improvements in the telegraph service relating especially to foreign countries. For instance, in June last a reduction was effected in the telegraph rates to British Guiana and to certain of the West Indian Islands; in the following month the telegraph was extended to Turk's Island, and an alternative route to Jamaica was provided by means of the cable recently laid from Bermuda to Jamaica *viâ* Turk's Island. In February a reduction in the telegraph rates to Mexico came into force; in October a number of additional telegraph offices were opened in the British possessions on the West Coast of Africa; in November a similar extension took place to certain of the French possessions on the same coast.

Motor Car Trials.—The Liverpool Self-Propelled Traffic Association have issued printed particulars of the forthcoming trials of motor vehicles for heavy traffic, which are to take place in August, 1899. General regulations, &c., as to vehicles eligible for competition, and so forth, are given. Copies may be obtained from the honorary secretary, Mr. E. Shrapnell Smith, Royal Institution, Liverpool.

The Institution of Electrical Engineers and Telephony.—We understand that the Council of the Institution of Electrical Engineers has appointed a committee to inquire into the future of electrical engineering in the domain of telephony in these kingdoms.

The Colombo Telephone Accident.—The *Colombo Standard* says that his Excellency the Governor has called for an official report on the accident in the Pettah, mentioned last week, which resulted in serious injuries to three native workmen of the Telephone Department. Mr. Montague, the Superintendent of Telegraphs, is inquiring into the matter.

Polyphase Machinery.—In view of the extensive use of polyphase machinery abroad, and the demand for it which is steadily increasing at home, it is interesting to note that a special course of instruction upon the commercial design of this class of plant will be given at Finsbury Technical College. The course, commencing March 7th, and extending over six evenings, will be given by Mr. A. C. Eborall, assisted by Mr. W. B. Woodhouse. We understand that this is the first time anything of the kind has been attempted in England.

Lectures.—A Bombay correspondent sends us a copy of an Indian newspaper containing a report of a lecture on "Wireless Telegraphy, practically illustrated," delivered by Mr. C. Chevallier, the general superintendent of the Eastern Telegraph Company there. He sends this to advise us that Bombay is not far behind the times.

Presentation.—The employés of the D.P. Battery Company, Limited, Old Charlton, Kent, and their friends held a smoking concert at the Angerstein's Hotel, Westcombe Park, Greenwich, on Saturday, 11th inst., for the purpose of presenting a demi-hunting English lever to Mr. J. Jones (works manager), who is leaving Charlton to take up the superintendence of the company's new works at Bakewell, Derbyshire. There was a large company present, and a lengthy programme was most successfully carried out. The presentation was made by Mr. J. Waddell, junior (who is taking over the charge of the Charlton works in succession to Mr. Jones).

The Electric Lighting of St. Paul's Cathedral.—With reference to the statement regarding the electric lighting of St. Paul's, it is stated in the *Times* that "Sir William Richmond has been promised the sum of £5,000 by Mr. Morgan, the New York banker, to defray the cost of such an installation of electric light in St. Paul's Cathedral as will serve to light up the mosaic decorations."

The Institution of Civil Engineers.—The seventh "James Forrest" Lecture will be delivered by Prof. J. A. Ewing, on Thursday, April 20th, at 8 o'clock, the subject being "Magnetism." The lecture will be repeated on Friday, April 21st, at 4 o'clock.

Benevolence.—Mr. J. M. V. Money-Kent entertained over 300 of the poor of Twickenham to dinner at the Town Hall there on 16th inst.

Some New Terms!—In the *Technology Review*, of which No. 1 lies before us, we find a quarterly magazine relating to the Massachusetts Institute of Technology, and therefore, in some sense, devoted to a narrow circle. We believe the Institute is held to be one of the leading technical colleges in America, and the fees are considerable. It is a little sad to find a review of a new work on matter, energy, force and work, sad, not because of the review, but to find that the new work proposes new terms. We will not define these terms. Suffice that we name them. One is *weightal*. The author has evidently imbibed the poundal to some purpose. There is also another new term employed, to wit, *kinergety*, which may also go its way undefined. Were we to follow the same unregulated craze for a novel terminology, we should like to find one for expressing the extreme unfitness of the first advertisement which follows the editorial pages, and which surely might have been refused admission.

The Royal Society.—Among the papers down for reading yesterday afternoon was one by Mr. J. Brown, "Some Experiments bearing on the Theory of Voltaic Action."

Accident.—On Tuesday, while a carriage was being removed from a trolley on the metals at the Clapham Road new station tunnel (City and South London Railway extensions), it suddenly heeled over and jammed the foreman, John Legg, between the trolley and the tunnel wall. He was terribly crushed, having received severe spinal injuries, as well as a broken collar bone. His condition was stated to be precarious.

NEW COMPANIES REGISTERED.

British Thermophor Syndicate, Limited (60,707).—This company was registered on February 15th, with a capital of £25,000 in £1 shares, to adopt an agreement with Salisbury-Jones and Bidwell, and to acquire, own, and work any patents and rights relating to heat, chemistry, and electricity. The first subscribers (each with one share) are:—William Robson, 2, Manor Villas, Merton, S.W., gentleman; Miss Edith Harbert, 17, Bedford Place, W.C.; Charles E. Gilbert, 6, Castle Bar Road, Ealing, W., gentleman; Frederick King, 28, Park Road, New Wandsworth, S.W., secretary; Ermyn Ward, clerk, and N. Haggett, stenographer, 17, Great Winchester Street, E.C.; J. Symm, 2, Cowper's Court, E.C., gentleman. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, 50 shares. Registered office, 2, Cowper's Court, Cornhill, E.C.

New Rottingdean Electricity Company, Limited (60,713).—This company was registered on February 16th, with a capital of £2,000 in £1 shares, to enter into an agreement with Samuel J. Thacker, and to carry on at Rottingdean, Sussex, the business of electricians, electrical and mechanical engineers, suppliers of electricity and electrical apparatus manufacturers. The first subscribers are:—Samuel J. Thacker, Rottingdean, Sussex, surveyor, 250 shares; George Mason, Rottingdean, Sussex, tutor, 250 shares; Chas. Reed, Rottingdean, Sussex, grocer, 300 shares; William Hilder, butcher, 50 shares; Frederick Thomas, Rottingdean, Sussex, hotel proprietor, 100 shares; Samuel Reed, Rottingdean, Sussex, gentleman, 100 shares; and Albert H. Swain, 5, Bedford Row, W.C., clerk. The first directors (to number not less than three nor more than seven) are Charles Reed, Samuel J. Thacker, Samuel Reed, George Mason, Frederick Thomas, and William Hilder; remuneration as fixed by the company.

William James Glover & Co (Established 1818) Limited (60,714).—This company was registered on February 16th, with a capital of £100,000 in £1 shares (of which 40,000 are 5 per cent. cumulative preference), to enter into agreements, dated February 7th, with Benjamin B. Glover, William J. Glover, George E. Heyl-Dia, Hanchett & Co., Limited, Robert B. Glover, and William Hanchett, and to carry on the business of cable and wire rope manufacturers, wire drawers, galvanisers, electricians, electrical and mechanical engineers, electrical apparatus manufacturers, telegraph, telephone, and electric cable manufacturers, India-rubber merchants, &c. The first subscribers (each with one share) are:—Benjamin B. Glover, St. Helens, mining engineer; William J. Glover, St. Helens, wire drawer; George E. Heyl-Dia, Higher Broughton, Manchester, electrical engineer; Francis W. Maxwell, Sandfield, Prestwich, architect; Robert B. Glover, St. Helens, engineer; B. Harvey Glover, St. Helens, cycle manufacturer; and William Hanchett, Dyer Street, Manchester, India-rubber manufacturer. The first directors (to number not less than three nor more than seven) are Benjamin B. Glover, William J. Glover, Robert B. Glover, and George E. Heyl-Dia; qualification, 500 shares; remuneration as fixed by the company.

Mornement & Ray, Limited (60,741).—This company was registered on February 17th, with a capital of £10,000 in £1 shares, to acquire and carry on the business of steam cultivators, threshers, hauliers, rollers, and agricultural, electrical, and general engineers now carried on at East Harling, Norfolk, by Edward Mornement, jun., and John N. C. Ray. The first subscribers (each with one share) are:—Edward Mornement, jun., East Harling, Norfolk, engineer; John N. C. Ray, East Harling, Norfolk, engineer; Mrs. Edward Mornement, East Harling, Norfolk; Alfred C. Swan, 7, Waldeck Road, West Green, N., land agent; David Parr, East Harling, Norfolk, engineer; Donald C. Swan, East Harling, Norfolk, clerk, Edward Mornement, sen., Rendham Hall, farmer; and Robert G. Barrell, Thetford, Norfolk, engineer. Registered without articles of association. Registered office, East Harling, Norfolk.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Douglas Southern Electric Tramways, Limited (45,701).—This company's annual return was filed on January 19th. The capital is £50,000 in £1 shares (30,000 preference), 25,573 preference and 15,472 ordinary shares have been taken up, and 13,407 of the former and 9,668 of the latter are considered as paid; £1 per share has been called on the others, and £17,970 has been received.

East Grinstead Electric Lighting Company, Limited (48,522).—This company's annual return was filed on November 4th, when seven shares were taken up out of capital of £15,000 in £1 shares (5,000 preference), but no calls have been made.

Direct West India Cable Company, Limited (53,956).—This company's annual return was filed on December 31st, when 12,000 were taken up out of a capital of £120,000 in £5 shares and £2 10s. per share called and £30,000 paid.

Doe Portable Electric Light and Power Syndicate, Limited (57,903).—This company's statutory return was filed on November 25th, when 7,208 shares were taken up out of a capital of £40,000, in £1 shares; £1 per share has been called on 7,201 and nothing on the others; £6,392 5s. has been paid, and £808 15s. is in arrears.

Direct Electric Generator Syndicate, Limited (46,342).—This company's annual return was filed on December 16th, when 99,725 shares were taken up out of a capital of £100,000 in £1 shares. 95,000 shares are considered as paid, and £4,725 has been received.

Continental Water and Electrical Power Syndicate, Limited (49,882.—This company's annual return was filed on January 5th. The capital is £26,000 in £1 shares (1,000 deferred). 19,500 ordinary and 890 deferred shares have been taken up, and £20,097 has been paid, leaving £293 in arrears.

Corbridge Electric Lighting Company, Limited (52,491).—This company's registered office has just been removed to 110, Pilgrim Street, Newcastle-upon-Tyne.

Direct Electric Generator (Foreign Rights) Syndicate, Limited (47,931).—This company's annual return was filed on December 16th, when 95,283 shares were taken up out of a capital of £100,000, in £1 shares; 95,000 shares have been issued as paid, and £283 has been received in cash.

CITY NOTES.

Central London Railway Company.

The seventh half-yearly general meeting of the shareholders of this company was held on Wednesday last week at 16, Great George Street, Westminster, Sir Henry Oakley presiding.

The Chairman, in moving the adoption of the report, said that the whole of the works, from end to end of the line, had been progressing steadily and efficiently at all points, that no point had been neglected, and that when the moment for completion arrived they would find the whole line ready for working order. The station by the Mansion House was the pivot upon which the time of completion must turn. The area which they had received without practically any cost, amounted to 19,000 square feet, and they had nearly completed the excavations there, and the whole of the vast traffic which passed daily in front of the Mansion House was supported entirely by the timbers they had put down. The next step was to insert the permanent steel work. In that work difficulties were imposed because of the necessity of conducting the work in such a manner that the traffic overhead should not be interrupted. They had to do the work at night, taking possession of a portion of the road at 8 at night, and returning to its normal state at 8 o'clock in the morning. Work of that sort was naturally slow, but he was assured that every advantage was taken of every opportunity to push forward the work, that there had been no disorder, and no special trouble, but simply the over-riding circumstances compelled them to do the work as he had described. They were much indebted to the Corporation of London for the facilities they had afforded the company. They had completed the subway for pipes and mains, which were now all safely housed. The passenger subway was completed, except the roof. Proceeding downwards to railway level, four out of the five lift shafts were completed. A portion of the work there had to be done under great pressure, due to the fact that they were working in the bed of the old Walbrook, the earth being still sodden, and unless with the support of artificial means it would be almost impossible to construct the tunnel. One of the tunnels at that point was completed and the other was rapidly advancing towards completion, and without risk or disaster to any of the buildings surrounding them. They had passed through some old vaults of a former Bank of England, which, when abandoned, were filled with concrete. They could not blast that out at such a place, and it had to be chiselled. They also came across the foundations of Sir Thomas Gresham's first Royal Exchange, which, so far as they affected the company's works, had also to be destroyed. They had obtained the most important site in London, and had completed connections with the City and South London Railway and with the Waterloo and City Railway, and with the City and South London extension to Islington, adjoining also with the Great Northern and City Railway at Finsbury Circus. The traffic from all these lines would be freely exchanged at the Bank station. One could hardly imagine a more admirable site than they had got at the Mansion House. Nine out of the twelve stations were completed, the three which were not finished being those at Davies Street, Chancery Lane, and the Post Office. At Davies Street they had been delayed by the fact that they came across the track of the Tyburn River. It had

often been asked when they proposed to be ready for work. They had consulted their engineer, but he had declined to give a definite answer. However, he informed them that everything was going on satisfactorily in the point of construction. It was hoped to have the line completed within the year. The commercial aspect of the undertaking had occupied the grave consideration of the board. With the object of collecting the fullest information with regard to the working of electric railways, their secretary (Mr. R. C. Graham) had spent some time in America, and had brought home a good deal of valuable information for their guidance. The chairman added that the board had not yet come to any definite decision on the question as to whether there would be only one class or more on the railway. Without committing himself, however, he might say that the tendency of their minds at present was in favour of there being two classes of fares. As to the interpretation of the contract, he was not prepared to state definitely whether the contractors would have to bear the total extra expense of meeting the various unforeseen difficulties which had arisen during the construction of the railway. That point would have to be settled upon the completion of the work.

Lord Colville seconded the motion, and the report was adopted, after a short discussion.

A special meeting was afterwards held for the purpose of approving the following Bill which the company were promoting in Parliament:—"A Bill to extend the time for the completion of the Central London Railway and for other purposes."

On the motion of the chairman, seconded by Lord Rathmore, it was agreed to.

National Telephone Company.

There was a large attendance of shareholders at the half-yearly meeting of the National Telephone Company, Limited, held at the Cannon Street Hotel on Friday last, when the chair was taken by Mr. J. S. Forbes.

The Chairman, in moving the adoption of the report, said that the income for the six months covered by the accounts showed that the receipts had increased by £66,104, and the working expenses had increased by £29,326, while the net balance had increased by £28,438. These were considerable increases upon increases, and afforded some indication of the progress made by the company from half-year to half-year. The paragraph referring to the rentals carried forward was a very significant one. The rentals carried forward for unexpired terms of running contracts amounted to £536,654, being an increase of £63,067. The available balance shown by the net revenue account was £172,037, and it was proposed to pay a dividend at the rate of 6 per cent. per annum on the first and second preference shares, at the rate of 5 per cent. on the third preference shares, and at the rate of 6 per cent. on the ordinary shares. This was the dividend the ordinary shareholders had now been used to for some half-years. They also proposed to transfer £50,000 to reserve, and carry forward £8,000 odd to the next account. He thought they might consider the result very satisfactory, considering the adverse circumstances under which the company carried on its work, and how they were handicapped in various ways. With regard to their capital account, that was a serious matter, considering their limited tenure of office. Their's was a company in which the capital account was never closed, and it was a matter which caused the board much anxiety. For the half-year under notice, £367,201 had been expended on capital account in the erection of 6,930 additional exchanges and private lines. But that sum did not show all they had done. They had improved their system in many places by replacing the single line by the twin line system, and where they had found municipalities sufficiently enlightened to permit of it, had removed the wires from the streets and had placed them underground. He need not say they had not met that enlightenment in London, but in the great industrial towns of the North, where they realised the importance of the telephone. In the six months they had paid to the Post Office £54,356 for royalties. The Post Office took 10 per cent. of their gross receipts, and that was an enormous incubus on the company. They were accused by the man in the gutter of being extortionists and of doing many other bad things, but the royalties were to be born in mind. They had to carry on their business under enormous difficulties. It must cost more to carry on a business which was obstructed. If they had no statutory powers to get a thing carried out, they had to conciliate adverse interests in the best way they could—in other words, they had to pay for it, or rather the public had to pay, because they had to be content with a less perfect system than they would otherwise get. A great deal of stress was laid upon the fact during the recent sittings of the committee, that the company was exempt from the condition as to the service of charges which, in the case of gas, railway, water, and electric light companies, were generally imposed by Parliament, and that seemed to be something which hardened the hearts of the committee. No one could have been present at that inquiry without noticing the effect that was produced by false impressions acting upon the minds of gentlemen both capable and honourable, but ill-informed. It was quite true, as Mr. Hanbury had said in the House of Commons, that the company had not only a monopoly, but one which was not under street control, or under stringent regulations. But it must be remembered that they were but the sins of their fathers, and it was not they who had the monopoly, but the Postmaster-General, and that they were nothing but the agents of the Postmaster-General in doing a work which many people thought that the Post Office could do better itself. Still, that was a policy which did not suit the Post Office, and the Postmaster-General and the Government were happy enough to get a number of people to form a company and do all the preliminary work and run all the preliminary risks attending such a new undertaking such as their's then was, and that was why they were not placed under those restrictions and regulations which Mr. Hanbury thought they ought to have been placed under. Mr. Hanbury had described it as a strange state of affairs, but he seemed to have forgotten that it was the direct consequence of the action of the Government, who, in several sessions, vetoed Bills lodged by the company with the express object of obtaining powers to enable them to carry on their business efficiently, and under such reasonable conditions as might be imposed. Therefore, in view of what had transpired, and as the board considered that the interests of the community required that the company should be vested with powers sufficient to enable them to conduct this important national business in an efficient manner instead of being left to the mercy and caprice of every individual who impeded their progress, the board had again deposited Bills in Parliament. Mr. Hanbury had also stated that the company had become a powerful monopoly and dangerous to the State, and referring to the company's capital of £6,000,000, stated that he had had an estimate prepared by the Post Office which suggested to him that the whole thing could be replaced for £2,500,000. Some writers in certain newspapers had also talked about replacing the whole thing for £1,000,000, but it was perfect rubbish, and such statements created a great deal of prejudice against the company. At that meeting they would propose a resolution authorising them to increase their borrowing powers by £1,000,000. As he had already stated, the question of the constant expenditure had caused them serious consideration in view of the short tenure of their office. At present they had no daylight, and had to deal with uncertain quantities. The further £1,000,000, however, they estimated would meet their wants for the next four years, and long before that time they thought they would get daylight as to what was going to be done.

Lord Harris seconded the motion for the adoption of the report, and, after the chairman had answered a few unimportant questions, the resolution was carried.

The Chairman then moved the necessary resolution giving the directors power to borrow or raise such further sum of money as they might think fit, provided that the amount borrowed or raised by the company, or outstanding, should not exceed three-fourths of the issued capital for the time being.

Lord Harris seconded the resolution.

Mr. Hall said he would like to know what would be left for division amongst the shareholders when the license expired in 11 years' time.

The Chairman said the term unexpired was 12 years. As he had already remarked, their embarrassment as a company turned upon the uncertainty of the future. It had been their policy to lay aside large reserves, the accumulation of which, with interest, was calculated to be sufficient to wipe out, at the end of the term, a large amount of the debt of the company to its shareholders. They must also remember that they were constantly increasing their plant, and were replacing it with all the latest inventions of scientists, and it could hardly reasonably be supposed that when their license expired their plant was to be looked upon as mere wreckage. There was little doubt, however, that long before that time they would have some indication of what was going to happen which would guide them.

The resolutions were carried.

Formal resolutions approving of the Bill the company has before Parliament were then proposed by the Chairman, who said that they were practically answering a challenge by bringing them in. Complaints had been made that they were an unregulated monopoly, but these Bills asked for a definition of their powers. Of course, it would mean haggling before the Committee as to what they would be able to get. The third Bill, which practically asked in a private Bill to go beyond the Telegraph Act, was a strongish order; but they thought that as they were in for it they might as well do the thing well. It was very possible that they would not get what they asked, except in the way that the Act might be altered, and so what the company asked for might be given to anyone.

The resolution was seconded by Lord Harris and agreed to.

The Chairman then proceeded to make a long statement on the whole history of the company till the present time. He contended that an honourable understanding was come to by the Post Office officials and the company with regard to the question of areas, and in fact, that the relations of the Government and the company should be that of loyal co-operation. They were now threatened with the withdrawal of many privileges and concessions in the shape of wayleaves, &c., and if that turned out to be the case it would be nothing less than a scandal. It was agreed that the company should look efficiently after the local areas and that the Government should extend the trunk system, but the Post Office were not carrying out the agreement loyally, with the result that the company had undertaken work which should have been carried out by the Post Office rather than that their subscribers should suffer. People who talked about the cost of replacing the system did not know the true facts. If there was competition wages would rise all round, and copper was rising and would rise more. They did not fear competition from the Post Office on equal terms. After all, the outcry against the company was an attempt to depreciate its property, and he challenged the Post Office to go to arbitration now.

The Charing Cross and Strand Electricity Supply Corporation, Limited.

The report of the directors states that the progress of the business has been very satisfactory. The Maiden Lane and Lambeth stations, and the plant and machinery, have been maintained in a high state of efficiency. A provisional order for parts of the Holborn and St. Giles's districts, such as are South of High Holborn and New Oxford Street respectively, has been granted to the corporation. An applica-

tion for a provisional order to supply electric energy within the City of London (supported by a very influential memorial of ratepayers and others) is under the consideration of the Board of Trade, and (if granted) application to Parliament will be made in due course to confirm the order. There has been connected up to the mains of the corporation during the past year the equivalent of 26,694 additional 8-C.P. lamps, making, with those previously connected up, the equivalent of 134,236 8-C.P. lamps. Eighteen and a half miles have been added to the mains laid, including 7 miles in the new districts of Holborn and St. Giles, making, with those already laid, 101¼ miles. The combined output in units from the stations of the corporation has increased by about 20 per cent. for the year 1898 over 1897. The rapid extension of the business of the corporation has necessitated a modification of the original plans of the station buildings at Lambeth; about 90 feet have already been added to the length of the engine room and boiler house, and additional boiler, engine and dynamo plant installed. The station will, however, have to be still further enlarged, and for this purpose it has become necessary to determine tenants' leases of parts of the properties at Lambeth not at present in the occupation of the corporation. The directors have acquired upon lease for 999 years a site upon which they are building a sub-station (rapidly approaching completion); from this station it is intended to distribute electric energy to the Holborn and St. Giles's districts, and to supplement the present supply in the northern parts of St. Martin's parish and the Strand district. It will be seen that the necessary outlay on building extensions, mains and plant, to cope with the present and prospective demand has been exceedingly heavy; to meet this outlay and provide for future requirements in the present areas of supply, the directors propose to increase the ordinary share capital of the Corporation by the issue of 20,000 shares of £5 each at a premium. The net earnings as shown in the revenue (No. IV.) account have amounted to £21,377 2s. 6d.; £4,600 1s. 8d. has been paid in respect of interest on debentures and temporary loans up to December 31st, 1898; and £4,500 was distributed as interim dividend at the rate of 6 per cent. for the half-year ended June 30th, 1898. A sum of £12,277 0s. 10d. remains, which added to the undivided profit of £3,014 18s. 4d. from last year's account, makes £15,291 19s. 2d., which the directors propose to deal with as follows:—

	£	s.	d.
To provide for dividend on 4½ per cent. preference shares (apportioned to December 31st, 1898) ...	4,499	17	9
To pay a dividend at the rate of £10 per cent. for the half-year ended December 31st, 1898, on the ordinary shares, (making with the interim dividend paid in August, 1898, £8 per cent. for the whole year)	7,500	0	0
And to carry forward	3,292	1	5
	£15,291	19	2

Mr. Stefano Gatti and Mr. R. Chadwick are the directors who retire by rotation, and being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson & Son, also retire, and offer themselves for re-election.

The Windsor Electrical Installation Company, Limited.

THE report of the directors to the shareholders states that the business of the company is progressing satisfactorily. The number of lamps and motors installed on December 31st, 1897, was equivalent to 4,985 of 8-C.P. During the year 2,929 were added, bringing up the total to 7,914 on December 31st, 1898, of which total 540 represent the motor power. The net profit for the year was: Installation, £1,003 6s. 8d.; lighting, £1,536 6s. 1d.; total, £2,539 12s. 9d., and to this must be added the balance brought forward from the previous year, making a total sum available for distribution of £2,830 9s. 7d. The work of the installation department is chiefly obtained through the influence of the directors and their friends, and as this may fall off considerably at any time, it has been considered advisable to deal with the profits of this department separately, and the directors have therefore pleasure in recommending that a dividend at the rate of 3 per cent. be declared out of the profit of the lighting department and a further 3 per cent. in the form of a bonus out of the profit on installation work, making 6 per cent. for the year. The directors also recommend that the sum of £793 15s. 2d. be set aside out of the profits to a depreciation, renewal, and reserve fund, which will leave a balance of £687 10s. 5d., and as no provision has been made in the accounts for directors' fees, the shareholders will be asked to vote them a sum for their services out of this balance, leaving the remainder to be carried forward.

W. T. Henley's Telegraph Works Company, Limited.

THE report of the directors, to be presented to the shareholders at the ordinary general meeting to be held at the Cannon Street Hotel on Friday, February 24th, 1899, at 1 p.m., states that of the £50,000 additional capital authorised by the extraordinary general meetings in 1897 the first issue of £25,000 was taken up by the shareholders or their nominees in 1897 at 60 per cent. premium, enabling the reserve to be increased by £15,000. The second issue of £25,000 was taken up by the shareholders or their nominees in 1898 at 80 per cent. premium, enabling the reserve to be increased by £20,000. The annexed accounts show that during the past year a net profit has been made of £33,394 18s. 7d. After payment of debenture interest and income-tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., there remains £27,823 7s. 9d., making, with £14,789 11s. 7d. brought forward from last year, a total of £42,612 19s. 4d. available for distribution. The directors have transferred £7,500 to the reserve (in addition to the £20,000 above mentioned), and they recommend the payment of the following dividends, viz.: On the preference shares 7 per cent., including the interim dividend of 3½ per cent. paid on September 1st last; on the ordinary shares at the rate of 12 per cent. per annum, including the interim dividend of 4 per cent., also paid on September 1st last, and a bonus of 2 per cent. per annum. These payments will, together, amount to £28,084 5s. 1d., leaving £14,528 14s. 3d. to be carried forward. The dividend warrants will be posted on February 28th, 1899. Major-Gen. George Hutchinson, C.B., C.S.I., and the Hon. Randolph Stewart retire by rotation in accordance with the provisions of the articles of association, and being eligible, offer themselves for re-election.

The London Electric Supply Corporation, Limited.

THE report of the directors states that in accordance with the resolution passed at the extraordinary general meeting of the corporation on June 7th last, the capital of the corporation has been reduced by £220,000, by writing down the nominal amount of the ordinary shares from £5 to £3 each. This reduction duly received the sanction of the court, and it has enabled the board to write off £181,688 16s. 2d. in the various works set forth in the capital account, and the whole of the preliminary expenses and debenture discount accounts. The capital account now stands at £736,521 14s. 2d. The issue of £200,000 first mortgage debenture stock—which was largely oversubscribed—enabled the board to pay off the whole of the debenture debt and loans as at June 30th last, and the undertaking passed again into your hands as from July 1st last. Stock Exchange quotations have been obtained for the ordinary and preference shares, and for the debenture stock. The board is pleased to state that the satisfactory progress of the business of the corporation to March 31st last, as described at the meeting held on July 7th last, has continued during the year. The number of lights added during the year was 31,221, being an increase of 25 per cent., the total number of lights at December 31st being 155,319, and the same ratio of increase has continued since the accounts were closed. The new 2,000 horse-power plant was finished in October and has worked satisfactorily during the winter. New distributing mains have been laid from Newington Causeway to Greenwich, and also in the whole of our compulsory area in Bermondsey, and partly in Rotherhithe. The plant and machinery have worked satisfactorily during the year, and have been entirely maintained out of revenue. The prolonged strike in the South Wales coalfield added materially to the generating costs during the year. The profit on the workings for the half-year ending December 31st is £13,535 5s. 6d., to which has to be added interest on deposits, £291 17s 8d., making a total of £13,827 3s. 2d. Out of this the interest on debentures to December 31st, viz., £3,344 3s. 7d., has been paid, leaving £10,482 19s. 7d. now to be dealt with. The board propose to deal with this amount as follows:—

By payment of a dividend at the rate of 6 per cent. per annum on the preference shares for the half-year ending December 31st	£7,207	10	0
And to carry forward	3,275	9	7
	£10,482	19	7

The retiring director is the Right Hon. Lord Wantage, V.C., K.C.B., who is eligible for re-election.

The Newcastle Electric Supply Company.

THE directors' report to the eleventh general meeting of the shareholders of the above company says:—

The demand for electricity continues to improve, the units sold having been 803,789, against 660,906 last year. The total profit for the year, including the balance brought forward from last year, represents a sum of £6,020 18s. 3d. Out of this the directors recommend a dividend of 8 per cent. for the year, on account of which an interim dividend of 3½ per cent. was paid on July 15th last, leaving a further dividend of 4½ per cent. now payable to the shareholders. The total dividend will absorb £4,026 18s. 1d., and the directors propose to deal with the balance of £1,994 0s. 2d. as follows:—

(*a*) To increase the reserve and depreciation account by a further sum of £1,000 which, together with the premiums on shares issued during the year increases the account to £7,700	£1,000	0	0
(*b*) To carry forward to next year the balance of	994	0	2
	£1,994	0	2

The capital expenditure has been increased during the year by about £15,000, in which sum is included the cost of another large set of generating plant and the general extension of the company's system to meet the growing demand for electrical energy. Arrangements are being made for still further increasing the capacity of the supply station, and also for supplying continuous current for power and other purposes for which several applications have already been

received. The special expenditure above mentioned has been met by the issue of 3,000 new shares, sanctioned at the last meeting of shareholders. The retiring directors are Dr. Spence Watson and Mr. James Tennant, who are eligible, and offer themselves for re-election. The auditor, Mr. Thomas Harrison, also retires, and is eligible for re-election.

Scarborough Electric Supply Company, Limited.

THE annual meeting of this company was held at the Grand Hotel, Scarborough, last week, Mr. G. Alderson-Smith, the chairman, presiding.

The CHAIRMAN, in moving the adoption of the report, and the payment of a dividend of 5½ per cent. per annum, said that the lamps had increased from 17,700 in 1896 to 22,000 in 1898, the receipts from £3,466 in 1895 to £5,448 in 1898, the profits from £937 in 1895 to £2,332 in 1898, and the dividend from 4½ per cent. in 1896 to 5½ per cent. in 1898.

The Hon. CHARLES A PARSONS (Newcastle-on-Tyne), in seconding the motion, said that his experience was that the larger the quantity of electricity produced, the greater the profit, and the lower the price to the consumer. At Edinburgh the price was under 4d. per unit. At Newcastle-on-Tyne, with a production of nearly a million units per annum, the net selling price was 4d. per unit, and the next year it would be under 4d.

The report and dividend were adopted, and a vote of thanks was accorded the chairman for presiding.

Cambridge Electric Supply Company.

AN ordinary general meeting of the company was held at the company's offices last Friday.

Mr. D MUNSEY, chairman of the board of directors, presided, and, in moving the adoption of the report, said their prospects were brighter than they had ever been before. The company had been asked to send in a tender for lighting the town, and they would do their utmost to have a part of the lighting of Cambridge.

Mr SIMPSON seconded, and expressed the opinion that the dividend would go on increasing.

Mr. W. BOND made a strong appeal for the reduction of the price of electricity from 7d. to 6d. per unit, stating that it was only 4½d. per unit at Bedford.

The report was adopted.

On the motion of Dr. LATHAM, a dividend was declared in accordance with the recommendation of the directors.

Mr. Simpson was re-appointed a director and Mr. Arthur Rutter the auditor.

It was also resolved, on the motion of Mr. A. MACINTOSH, to increase the remuneration of the directors to 200 guineas per annum.

City of London Electric Lighting Company.

THE report for the year 1898, to be presented to the general meeting to be held in London on 1st prox., states that the expenditure on capital account during the year amounted to £90,968. The directors propose to make a further issue of the authorised ordinary shares in the course of this year to provide for extensions of works and plant, necessitated by the increasing demand for electric energy. The total revenue for the year was £175,608, from which must be deducted the following items:—Expenses of generation and distribution, £48,449; rents, rates, taxes, general and special charges, £27,979; transfer to depreciation fund No. 1, £17,000; transfer to reserve fund, £3,075; amount written off suspense account, £1,333—together £97,841, and leaving £77 767, to which must be added the balance brought forward from 1897, £1,055, making a total available revenue of £78,822. Of this sum the following amounts have been distributed:—Interest on debenture stock for the year 1898, £19,333; interim dividend on £400,000 6 per cent. preference shares, paid in July last on account of the distribution for the year, £11,600; interim dividend at the rate of 5 per cent. per annum on £500,000 ordinary shares, fully paid, and £100,000 ordinary shares (November issue, 1897), paid in July last on account of distribution for the year, £12,929—together absorbing £43,832, and leaving for further distribution £34,959. The directors now recommend that the following dividends for the year 1898 be declared, subject to the deduction of income-tax, to members registered in the books on 15th inst.:—On the preference shares, 12s. per share, being a distribution for the year at the full rate of 6 per cent. Of this sum 6s. per share was paid on account in July last, and it is proposed that the balance of 6s. per share be paid. On the ordinary shares, Nos. 40,001 to 90,000, 12s. per share, being a distribution at the rate of 6 per cent. for the year. Of this sum 5s. per share was paid on account in July last, and it is proposed that the balance of 7s. per share be paid. On the ordinary shares, Nos. 90,001 to 100,000 (November, 1897, issue), 8s. 1d. per share, being a distribution at the rate of 6 per cent. for the year, calculated from the due dates of the respective instalments, paid in respect of capital, to December 31st, 1898. Of this sum 1s. 9d. per share was paid on account in July last, and it is proposed that the balance of 6s. 4d. per share be paid. This will absorb £31,578, and leave a balance of £3,382 to be carried forward. The directors regret the decrease in the rate of dividend on the ordinary shares. It has been mainly caused by the reductions made in the charges to consumers; by the decreased consumption of current per lamp owing to the unusual brightness of the weather during 1898; by the increased cost of coal, and by the increased amount of capital which had to be issued in advance to provide plant and buildings for the steadily growing business of the company, and which capital ranked for dividend in the past year. The statutory provision for depreciation and reserve funds, in accordance with the City of London Electric Lighting Act, 1893, has been made, of which £20,075 has been set aside out of revenue. The City Corporation availed itself of its rights under the contracts to inspect the accounts of the company up to December 31st, 1897, in order to satisfy themselves that the regulations with respect to the statutory depreciation and reserve funds had been complied with. In consequence of the decreased receipts, owing to the reduced charges, &c., the generation and distribution expenses for the year, including repairs and renewals, were 36·1 per cent. of the gross earnings, as compared with 31·3 per cent. in 1897, 34 per cent. in 1896, 36·87 for 1895, 46 for 1894, and 51·2 for 1893. The applications for provisional orders made to the Board of Trade by the Charing Cross and Strand Electricity Supply Corporation, the Smithfield Markets Electric Supply Company, and the Metropolitan Electric Supply Company respectively are being actively opposed by the directors. The applications and objections of the company thereto are now under consideration by the Board of Trade.

Telegraph Construction and Maintenance Company, Limited.—The report shows a net profit of £71,594 after charging the interest on the debentures. To this sum must be added £33,841 brought forward, making a total of £105,435. From this amount is deducted the interim dividend of 5 per cent. paid in July, amounting to £22,410, leaving £83,025 to be dealt with. Of this sum the directors propose to distribute a dividend of £1 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1 16s. per share, or 15 per cent., tax free, leaving £38,205 to be carried forward.

House-to-House Electricity Supply Company.—It is stated that for 1898 the ordinary shares are to receive 6 per cent., while a sum of £4,000 is placed to depreciation account, and £159 carried forward.

Hove Electric Lighting Company, Limited.—The report for the year 1898 states that the units sold during the past year were 350,354, as compared with 268,243 for the previous 12 months, while the gross revenue amounted to £9,480, as against £7,269 in 1897. The gross expenditure shows an increase of £723 over the expenditure of the previous year. The net result is a profit for the year of £5,089, an increase of £1,487. The directors propose to write £247 off the preliminary expenses account, to place £1,000 to reserve, to declare a dividend at the rate of 8 per cent., per annum for the half year, making, with the interim dividend, 6½ per cent. for the year, and to carry £400 forward.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—Crompton & Co., Limited—further issue of £17,150 5 per cent. first mortgage registered debentures; Eastern Telegraph Company, Limited—£500,000 3½ per cent. preference stock in lieu of the provisional certificates now quoted.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending February 18th, 1899, were £178 6s. 8d.; aggregate to date £1,060 0s. 10d.

The Bradford City Tramways.—The receipts for week ending February 19th 1899, were £288 10s. 4d.; total receipts to date, £7,285 19s. 6d.; miles of track open, 4·72; car miles run, 5,868; number of cars, 16.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending February 17th, 1899, were £2,594 18s. 11d.; corresponding period, 1898, £2,399 2s. 8d.; increase, £195 16s. 3d.

The City and South London Railway Company.—The receipts for the week ending February 19th, 1899, were £1,057; week ending February 20th, 1898, £1,051; increase, £36; total receipts for half-year, 1899, £8,894; corresponding period, 1898, £8,565; increase, £329. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending February 18th, 1899, were £147 13s. 8d.; week ending February 19th, 1898, £104 13s. 9d.; increase, £42 19s. 11d. Total receipts to date, 1899, £1,000 14s. 4d.; corresponding period, 1898, £747 17s. 11d.; increase, £252 16s. 5d. Miles of track open week ending February 18th, 1899, 3; week ending February 19th, 1898, 3. Car miles run week ending February 18th, 1899, 4,294; week ending February 19th, 1894, 2,727. Number of cars, week ending February 18th, 1899, 11; week ending February 19th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, February 17th, 1899, were as follows:—D. U. T. Co., horse cars, £1,742 5s. 9d.; ditto, electric cars, £903 8s. 3d.; D. S. D. Co., electric cars, £636 11s. 1d.; total, £3,282 5s. 1d.; corresponding week last year—D. U. T. Co., horse cars, £2 615 2s. 10d.; ditto, electric cars, £113 4s. 5d.; D. S. D. Co., electric cars, £896 11s. 1d.; total, £3,124 18s. 4d.; increase, £157 6s. 9d; aggregate to date, £21,793 6s. 8d.; ditto last year, £21,692 2s. 7d.; increase to date, £281 4s. 1d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways. — The receipts for the week ending February 15th, 1899, were £339; total receipts to date, 1899, from June 29th, 1898, £8,801. Miles of track open, 3½. Car miles run, 5,289. Number of cars, 10.

The Liverpool Overhead Railway Company.—The receipts for the week ending February 19th, 1899, amounted to £1,297; corresponding week last year £1,320; decrease, £23.

The South Staffordshire Tramways Company.—The receipts for week ending February 17th, 1899, were £640 12s. 9d.; aggregate receipts for six weeks, £4,090 8s. 6d.; week ending February 18th, 1898, £607 1s. 5d.; aggregate receipts for six weeks, £4,145 0s. 2d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Feb. 15th.	Closing Quotation, Feb. 22nd.	Business done during week ended Feb. 22nd, 1899. Highest.	Lowest.
124,400l	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	100½	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	..
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	..
905,560l	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	67 — 69 xd	67 — 69	67½	...
3,047,220l	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	119 — 120xd	119 —120	119¾	119
3,047,220l	Do. do. Deferred...	Stock	...	...	18s. %	15½— 15¾xd	14½— 15	15⅝	14⅝
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	...	16 — 16½	16 — 16½	16 5/16	16
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	180 —190	180 —190	188	...
1,332,523l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106½	106
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	...	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	9½— 10½	9½— 10½	10¼	9 15/16
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17½— 18½	17½— 18½	18⅛	18
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	104 —107%	104 —107%	...	...
60,710l	Direct United States Cable	20	2½ %	...	...	12¼— 12¾	12 — 12½	12½	12
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —105	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	179 —184	179 —184	183	180
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	104 —107	104 —107	106½	106
500,000	Do. Prov. Certs., all paid	...	...	...	...	103 —106	104 —107	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	99 —102	99 —102	...	...
1,432,268l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	126 —130	126 —130	128	127
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	17¾— 18¼	17¾— 18¼	18 3/16	17 15/16
16,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	125 —129	125 —129	...	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	103	102½
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	...	12¾— 13¼	12¾— 13¼	13⅛	12⅞
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17⅛	17
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	29½— 30½	29½— 30½	29 15/16	...
150,000l	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	...	101 —104	101 —104	...	...
97,800	Halifax & Bermuda Cable, 4½ % 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	58 — 61	58 — 61	58	...
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	109 —112	109 —112	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	6 %	6 %	5⅞— 6⅛	5⅞— 6	6 1/16	5 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	15½	15⅜
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅝— 5⅞	5½— 5¾	5⅝	5½
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100 —102	100 —102	101½	101
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝— ¾	⅝— ¾	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	141½	139½
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	...	...
151,733l	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000l	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	100 —103	100 —103	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
64,269	Western and Brazilian Telegraph	15	2 %	3½ %	...	12½— 13	12½— 12⅝	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	8¼— 8⅝	8 — 8½	...	...
33,129	Do. do. do. Def. Ord.	7½	nil	½ %	...	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	1 %	⅜ %	...	1⅝— 1⅞	1⅝— 2	1⅞	1 13/16
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10½— 10⅝	10½— 10⅝	10⅝	10 7/16
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	8½— 9½	8½— 9½	9⅜	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	104 —107	104 —107	...	...
158,100l	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11 — 12	11½— 12½	12⅛	11⅞
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	...	9 — 10	8½— 9½	...	...
60,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	114 —116	114 —116	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	7 %	10 %	6 %	19 — 20	18½— 19½	20	18½
10,000	Do. Ord. Nos. 90,001 to 100,000	10	...	...	...	18 — 20	18½— 19½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15 — 16	15½	15⅛
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	124 —129	124 —129	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	nil	nil	...	12 — 13	12½— 13½	12¾	...
10,000	Do. do. do. Nos. 30,001 to 40,000 ...	10	...	...	...	12 — 13	12½— 13½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	14½— 15½	14½— 15½	15½	14 15/16
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5¼— 5⅜	5¼— 5⅜	5⅜	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	4 %	...	9 — 10	9 — 10	9⅜	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9½— 10½	9½— 10½	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 4	3½— 4	4	3 15/16
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6½— 7	6 13/16	6¾
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	104 —106	104 —106	105⅜	105
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	...	17½— 18½	17 — 18	17⅝	17½
22,500	Do. Nos. 62,501 to 85,000, £7 paid ...	10	...	...	...	14 — 15	13½— 14½	...	...
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	118 —121	118 —121	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	17½— 18½	17½— 18½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	16 — 17	16½— 17½	17¼	15⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10 xd	9 — 10	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3¼— 3½	3¼— 3½	3 7/16	3¼
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	15 — 16	15½— 16½	16⅜	15⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Feb. 15th.	Closing Quotation Feb. 22nd.	Business done during week ended Feb. 22nd, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3 — 3½	3 — 3½	3⅜	3⅛
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	...	...
30,000	British Electric Traction	10	...	...	...	17 — 18	16½— 17½	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13¼— 13⅜xd	13¼— 13⅜	...	...
100,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	121 —123	121 —123	122½	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅝— 2⅛	1⅝— 2⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	12½— 13½	12½— 13½	13	12⅝
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	113 —116	113 —116	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9¾— 10¼	9¾— 10¼	10⅛	9⅞
178,303	Do. do. do. £8 paid	10	...	...	...	7¾— 8¼	7¾— 8¼	7⅛	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3½— 4	3½— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4 — 4½	4 — 4½	4 7/16	4⅜
630,000*l*	City and South London Railway	Stock	1 5/16 %	1⅜ %	2½ %	72 — 74 xd	71 — 73	74	72
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4⅜— 5¼	5 — 5½	5⅜	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	2¾— 3¼	3¼— 3¾	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	98 —101	98 — 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5⅛ %	6 %	...	2¼— 2⅜	2¼— 2⅜	2⅜	2⅜
17,139	Do. do. do. "A" Shares, 01—017,139	5	5⅛ %	6 %	...	4 — 5	4 — 5	4⅝	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	97 — 99	98¾	98
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2¼— 2½	2¼— 2½	2 7/16	2⅜
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	3 5/16	3 1/16
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —105	103 —106	105½	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅛— ¼	⅜— ⅝	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅜— ⅝	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	25 — 26	25½— 26½	26½	25⅜
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	18⅝	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	111 —116	113 —116	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	23 — 24	23 — 24	23¾	23 1/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅜ %	3¼ %	3¼ %	10⅛— 10¼	10 1/16— 10 5/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14¾— 15¼	14¾— 15¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	38 — 42	38 — 42	41½	40½
13,400	Telegraph Manufacturing, Ord Nos. 6,601 to 20,000 ...	5	...	...	...	8¾— 9¼	8¾— 9¼	9⅛	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5¾— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	109 —112 xd	109 —112	110	...

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10¼.
British Aluminium, Ordinary, 10—11; 7 % Pref., 10½—11½.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—14; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 8/- to 9/-.
Smithfield Market Electric, 4—4½.
*T. Parker, £10 (fully paid), 15¾.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, February 22nd.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£26	£25 10	10/- inc.
a Lead, Nitrate .. .. .. per ton	£23 10	£23	10/- inc.
a „ White Sugar .. .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3½d.	3½d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	67/-	67/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..
METALS, &c.			
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£65 to £130	..	..
c Brass (rolled metal 2' to 12') basis per lb.	8½d.	8½d.	..
c „ Tube (brazed) .. .. per lb.	10d.	10d.	..
c „ Wire, basis .. .. per lb.	8½d.	8½d.	..

METALS, &c. (*continued*).	This week.	Last week.	Increase or Decrease.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£79	£79	..
g „ Wire (basis price) .. per lb.	9¾d.	9¾d.	..
g „ Sheet .. .. .. per ton	£79	£79	..
g „ Rod .. .. .. per ton	£79	£79	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. .. per lb.	4/2	4/2	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	47/9	48/6	9d. dec.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i „ Wire galvanised No. 8 .. per ton	£9 5	£8 15	10/- inc.
g Lead, English Ingot .. .. per ton	£15	£15	..
g „ „ Sheet .. .. per ton	£15 10	£15 15	5/- dec.
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings per lb.	1/- to 1/4	..	..
p „ rolled bars & rods per lb.	1/- to 1/4	..	..
p „ r'l'd strip & sheet per lb.	From 1/2	..	..
o Platinum .. .. per oz.	£3 6 6	£3 6 6	..
p Silicium Bronze Wire .. .. per lb.	10d. to 1/1	..	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£115	..
g „ foil .. .. per lb.	1/6	1/6	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/6	1/6	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £65	..	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	6¼d.	6¼d.	..
j „ Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j „ Hemp, 8 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£31 10	£30	30/- inc.
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£31	£31	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

THE ACTION OF MAGNETISED ELECTRODES UPON ELECTRICAL DISCHARGE PHENOMENA IN RAREFIED GASES. PRELIMINARY NOTE.

By C. E. S. PHILLIPS.*

The experiments herein described were undertaken in order to ascertain what would be the action of strongly magnetised electrodes upon electrical discharge phenomena in rarefied gases, and especially upon the charged residual gas, when all external stimulation had ceased.

For this purpose an apparatus was constructed, as shown in fig. 1,

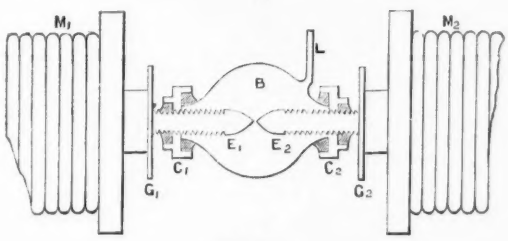


Fig. 1.

consisting of a soda-glass bulb, B, open at both ends for the purpose of inserting the pointed soft iron electrodes, E_1 and E_2, and with the leading tube, L, attached for connection to a sprengel air pump.

No precaution was taken to keep mercury vapour out of the bulb, B, during the experiments. Each electrode had a screw thread of suitable pitch cut upon it, in order that the brass cups, C_1 and C_2, when screwed into position and sealed with cement to the glass, might serve to keep the electrodes central, to reduce the possibility of their rushing together under the influence of strong magnetic forces, and to seal air-tight the two ends of the bulb.

The poles of a large electro-magnet, M_1 M_2, were insulated from the electrodes by means of two thin glass sheets, G_1 G_2. A discharge from the secondary of an induction coil or other suitable source, could then be passed through the bulb, the exhaustion varied and the electrodes magnetised at pleasure.

Results.

A pressure was obtained within the bulb, such that cathode rays began to be freely emitted by the negative electrode, and from the screw thread cut upon it there came a helix of rays which gave rise to the appearance of golden-green rings of fluorescence upon the inner surface of the glass vessel, B. When the electrodes were magnetised these green rings twisted somewhat and moved forward, the direction of rotation depending upon the polarity of the magnet emitting the rays.

It has already been noticed † that an external magnet placed behind the negative electrode will cause rotation of the green fluorescence upon the walls of an exhausted tube, and that the direction of motion is opposite to what it would be in the case of a wire placed at right angles to the axis of the magnet, and in which a current flowed away from the pole. In the above experiment, the rotation was only partial but agreed in direction with the results of other observers.

The bending forward of the rays is evidently dependent upon their partial rotation, because, on reversing the polarity of the magnet emitting them, the direction of their rotation was also reversed, and the bending forward still occurred. That a positively charged body, moving in a definite direction sets up magnetic whirls in planes transverse to its path, is generally accepted, the whole effect indeed being treated as a current flowing in the same direction; and it seems only logical to conclude that were the body negatively charged, its motion would give rise to effects similar to those accompanying a flow of current in the opposite direction. From this we should expect cathode rays to behave towards a magnet, just as would a wire carrying a current in the opposite direction to that in which the charged particles, constituting the rays, are supposed to be moving—a view which is borne out by experiment.

The pressure was then still further lowered, until a 3-inch spark from a 10-inch Apps induction coil was only just able to start the glow. Under these conditions, irregular green patches flickered upon the inner surface of the glass; but when the electrodes were oppositely magnetised these green flecks immediately vanished, and, the resistance of the residual gas within the bulb becoming smaller, a hazy blue cloud formed between the points.

Owing to the ever varying charges upon the inner surface of the bulb and upon the electrodes themselves, it could not be ascertained whether this blue cloud tended to assume a definite geometrical form or not. It was found, however, that, after a strong stimulation of the bulb had taken place and then been stopped, the electrodes meanwhile remaining unmagnetised, on exciting the magnet, a luminous ring suddenly appeared within the bulb, between the pointed ends of the electrodes, and in a plane at right angles to the direction of the magnetic lines of force.

The ring shone brightly for a moment, when the magnet circuit was "made," and it was more sharply defined at high exhaustions; becoming, in fact, hazy and indefinite, if the pressure within the bulb was slightly increased.

On the other hand, the rarefaction must not be carried too far, for it is necessary, in order to obtain this luminous effect, that the residual gas within the bulb should be very generally stimulated by the passage of the discharge. The following combinations were then tried:—

After stimulation, both the leading wires attached to the electrodes were removed from the secondary of the induction coil, and (*a*) insulated, (*b*) joined together and insulated, (*c*) joined together and connected to earth, (*d*) one insulated and the other connected to earth. In all these cases the ring formed equally well when the pointed ends of the electrodes were oppositely magnetised. On the other hand, as long as the points were made either both N or both S, no ring could be obtained.

In another experiment, after the exhaustion had been carried somewhat further and the bulb strongly stimulated, a second ring flashed out momentarily when the magnet circuit was completed; it formed concentrically with the smaller and more permanent ring, and appeared to be situated upon the inner surface of the glass bulb.

Observations as to the actual mode of formation of what I venture to call the primary ring, *i.e.*, the smaller one of the two, could at this stage of exhaustion be conveniently made. It appeared to emanate originally as a bright stream from between the electrodes, and then to curl rapidly round the magnetic axis, that portion most distant from the electrodes gaining upon the rest, ultimately disengaging the tail of the stream from between the points, and thus forming an equatorial circle of light within the bulb. The ring then spread out and became somewhat wider and less well defined, and as it gradually died away the glow seemed to be rotating more and more slowly until at last it flickered and vanished.

It appears, in fact, that this luminous ring spins between the electrodes from the moment it forms under the action of the magnet, the high initial velocity with which, in that case, it must be set in motion tending to keep it rotating, even after the magnetic lines have reached a maximum. The gradual expansion of the ring, which begins to take place immediately it has formed, may, according to this view, be due partly to centrifugal force, and also partly to the attraction exerted by an electrostatic charge residing upon the inner surface of the glass walls of the bulb. It is significant, too, that when the ring had all but disappeared, the sudden turning off of the magnet slightly revived the luminosity. At the instant the ring formed, the glass walls of the bulb became charged so strongly that a spark could, in some cases, be seen to pass between the outer surface of the glass and the brass cups, C_1, C_2, attached respectively to either electrode. It should be noticed that the ring is generally very sensitive to variations in the charge upon the glass walls, and that touching the bulb at various places with the fingers produces vigorous movements of the glow within.

In a bulb, the diameter of which was about 3 inches, the ring threaded itself on to either of the electrodes, E_1 or E_2, when the centre of the bulb was electrically connected to the cups, C_2 and C_1, respectively.

When only one electrode was magnetised, after the bulb had been stimulated, the rotation of the glow was more easily seen, owing to the formation around the magnetised electrode of a wide, spiral-shaped, luminous cloud, which was apparently rotating as it became more and more dim, and it was then noticed that the direction of rotation could be reversed by reversing the polarity of the magnetised electrode. No change in the effect was observed when the connections to the bulb were reversed.

The form of the electrodes was next varied, but the effects produced were mainly the same. With a pointed cathode and a concave anode, the ring formed as usual, but it was observed that whenever these relations were reversed, no ring could be obtained. Indeed, having first of all stimulated the bulb with the concave electrode

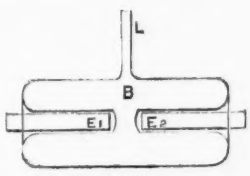


Fig. 2.

negative, it was not only impossible to obtain a ring on magnetising the electrodes, but even when the connections were reversed, still no ring would form until after repeated or prolonged stimulation of the bulb. Neither did a ring form when the electrodes were magnetised, so that like poles faced each other—a similar result to that already observed with pointed electrodes.

It may be worth recording that when pointed electrodes were employed, the ring formed equally well, whether the bulb was stimulated by means of a Tesla oscillator, an induction coil, or a Wimshurst influence machine.

Finally, experiments were made with external magnetised electrodes, the exhausted bulb being shaped as shown in fig. 2. In this case, of course, the discharge was oscillatory, and consequently the effects were not very directly comparable to those already described.

* Communicated to the Royal Society by Sir William Crookes. Received November 30th. Read December 15th, 1898.

† *Phil. Trans.*, 1879, Part II., p. 657.

At a low pressure, however, and when the bulb was filled with a green glow, on disconnecting the induction coil and magnetising the electrodes, a flash of white light was observed within the tube, and irregular green splashes momentarily made their appearance upon the glass.

In conclusion, I desire to offer my thanks to Dr. Silvanus P. Thompson, F.R.S., for kindly permitting me to use the Tesla apparatus at his laboratory, and for the interest he has taken in the progress of these experiments.

WIRELESS TELEGRAPHY IN 1849.

[Communicated by Charles Bright, F.R.S.E.]

From the following letter * it will be seen that so-called "wireless" telegraphy, if not as old as the hills, was at any rate publicly suggested by Mr. J. W. Wilkins—a telegraph engineer of the earliest days—for electrically spanning the English Channel, before what may equally well be termed wire-*full* telegraphy had been so applied:—

Copy of Letter appearing in "Mining Journal," March 28th, 1849.

"Telegraph Communication between England and France.

"To the Editor, &c.

"Sir,—Allow me, through the medium of your valuable journal, to draw attention to a theory upon which a telegraphic communication may be made between England and France without wires; and as this mode of telegraphy seems to be the ultimatum of all wishes upon the subject, I do not hesitate to lay before your readers, for investigation, experiment, or actual use, this, my view of the subject.

"I take for certain (as experiments I have made have shown me) that when the positive and negative poles of a battery are dipped into or connected with any conductory medium the electricity around the positive pole is positive, being diffused in radial lines, and the part around the negative pole is negative in radial lines converging towards it, supplying the electricity requisite for the decomposition of the substances composing the battery. This understood, it is evident that when a positive radial line sets out from the junction of the battery with the earth it makes its way to, or is attached by, the nearest negative portion of *earth*, at last meeting the negative pole of the battery restoring the equilibrium. From this it appears that the first portion of electricity will pass in a straight line between the two poles, being the shortest between them, and the rays will then form curves between the poles, until, by reason of increasing distance, they are no longer influenced by one another, without a better medium of conduction be interposed in their circuit.

"It is natural to suppose that all parts of the earth are not of one uniform density; if so, then some parts are positive and others negative. Then from this it is easy to see that some of the electricity flowing from the positive pole is the means of restoring equilibrium to negative portions of the earth—not necessarily rendered so by the negative pole of the battery; and also positive portions, for the same reason, rendered neutral or negative (*see* note No. 1 below.)

"These rays of electricity may be collected in a certain quantity between the point where they start, and where they are rendered neutral, and by the interposition of a metallic medium that shall offer less resistance than the water or earth—obviously the nearer the battery the greater the chance of collecting them. I do not anticipate the distance of 20 miles is at all too much (with the means we can use to compensate it) to collect a sufficient quantity of current to be useful for telegraphic purposes. Still, the quantity would be small, and with the present telegraphic instruments would not be detected at all. The current in the wire (of the instrument used) must be detected, not by its amount, but that it exists in *any quantity*, however small. If, then, electricity can be collected in France, simultaneously with a discharge from a battery in England, all that is required is to find out what to do with it, so that it shall indicate its presence.

"I will now lay before you the arrangement I propose for carrying out this design.

"No. 1. Upon one shore I propose to have a battery that shall discharge its electricity into the earth or sea, having a distance of some five, 10, or, perhaps, 20 miles, as the case may be, between the poles.

"No. 2. Let a similar length of wire be erected on the opposite coast, as near to, and as parallel with it as possible, having its ends dipping into the sea or earth.

"No. 3. Within the above circuit have an instrument consisting of about 10 or 20, or more, square or round coils of finest wire, of best conductibility, suspended on points or otherwise, being part of circuit No. 2. Suspend this coil before or between the poles of an electro, or permanent magnet or magnets, and in either case any current passing through the coil will be indicated by its moving or shifting position (*see* note No. 2 below). *This* would then constitute the telegraph. It now would only depend upon the distance between the poles of the battery in one case, and the ends of the circuit wire in the other, together with the lightness of the coils of wire used—having reference to their number—and the power of the magnet or magnets used to deflect it, although that would be easy of adjustment, and when once done, are certain to be of continuance—at all events, much more so than a submerged wire across the Channel.

"I hope someone will take up this suggestion and carry it out practically, to a greater extent than my limited experiments have enabled me; for, of its truth, for long, as well as short distances, I am satisfied, and want of means only prevents me from carrying it out at once. I venture to say what I have, on an experience in electricity of 10 years, and a practical acquaintance with electric telegraphs of near five years.

(Signed) J. W. Wilkins.

"No. 1 Note.—The present electric telegraph is affected by what is *commonly* termed 'Auroras'—or a current of electricity passing along the wires—of course, entering and passing through the coils used, thereby deflecting the needle. While inspector of telegraphy on the lines between Rugby and Newcastle, I have known that, for hours at a time, the telegraphs on particular sections of the road have been rendered useless from this deflection, often moving the needle from the perpendicular to either side, and back again, in a few minutes, giving evidence of different currents flowing in the same direction, or the same currents in different directions. As the telegraph wires are terminated at each end with a plate in the earth, these wires are thus portions of the earth itself, and currents flowing from place to place pass along them.

"No. 2 Note.—The coils under these circumstances would, if between the poles of the magnet, move from any position and lie parallel to the poles, and, if in front of the poles of the magnet, would move from side to side in a plane parallel to the ends of them.

"I claim these movements as design or invention of my own, as telegraphs, working with the least amount of electricity and resistance; and the movement depends not so much upon the current passing as on the power of the magnet or magnets used."

* In reading this, it must be remembered that the terms in use then were widely different from those of to-day—let alone the disparity in views.—C.B.

ON THE REFLECTION OF CATHODE RAYS.*

By A. A. CAMPBELL SWINTON.

(*Abstract.*)

The author has investigated the para-cathodic rays, so called by Prof. S. P. Thompson, which in a focus tube proceed from the front surface of the anti-cathode, and cause the green fluorescence of the glass. By means of a tube in which these rays cast the shadow of a wire upon the opposite end of a tubular annex, he has studied their magnetic deflection, and finds it to be in a similar direction to that of cathode rays. By means of another tube containing a small Faraday cylinder, into which some of the para-cathodic rays were caused to pass, he has determined that the para-cathodic rays carry negative charges. The author has previously shown that para-cathodic rays produced Röntgen rays, where they strike the glass; they also produce green fluorescence, hence he concludes that para-cathodic are simply reflected cathode rays.

The mechanical force exerted by these reflected cathode rays appears to be exceedingly small, and is insufficient to account for the inverse rotation of radiometer wheels, which, as described by the author in the *Phil. Mag.* for October, 1898, occurs when the wheels are placed just outside the cathode stream. Indeed, all experiments designed to produce rotation by the impact of reflected cathode rays failed, and in some cases the wheels were found to rotate most persistently in a contrary direction, showing that whatever be the cause of such inverse rotation, it is more potent than the force of impact of the reflected rays.

The reflection of cathode rays is largely diffuse, but not altogether so; experiments with a polished concave platinum reflector, capable of rotation, gave, under certain conditions, distinct visual evidence of true specular reflection, with equal angles of incidence and reflection. In addition to the specularly reflected rays, the anti-cathode reflector was also found under certain conditions to give off a well-defined beam of other rays normal to its surface, which caused fluorescence of the glass. The exact nature of these normal anti-cathode rays calls for further investigation.

The author has studied and quantitatively measured the electric charges carried by reflected cathode rays for different angles of incidence and reflection by means of special apparatus. A tube was constructed for this purpose, in which a polished flat platinum reflector could be set at different angles to the incident cathode rays. This tube was fitted with a movable Faraday cylinder, which was capable of rotation round the reflector, so that throughout a single plane the whole field traversed by the reflected cathode rays could be explored. The amount of negative charge imparted to the movable Faraday cylinder at different positions, and with different angles for the reflector, were measured both by a reflecting galvanometer, and also by a quadrant electrometer. Many complete series of observations for different positions, both of reflector and cylinder, were made, and all agree in showing that the field of reflected cathode rays is not uniform, but increases more or less gradually on both sides up to a maximum, which occurs almost exactly at the point that makes the angle of reflection equal to that of incidence.

Further experiments show that the amount of charge carried by the reflected rays increases as the angle of incidence is made more slanting, and that the electrification of the reflector itself, which is strongly negative when the incidence of the primary cathode rays is

* Communicated to the Royal Society by Lord Kelvin, F.R.S. Received January 25th. Read February 9th, 1899.

normal, gradually falls to zero as the incidence is made more slanting, until with very slanting incidence the electrification becomes slightly positive.

The author compares this result with that described by him in the *Roy. Soc. Proc.*, Vol. 63, pp. 434-435, viz., that cathode rays which strike the anti-cathode normally, are more efficient in producing Röntgen rays than those which impinge upon it very much on the slant.

The author points out that these results support the view that the Röntgen rays are actually due to the electric charges carried by the cathode ray particles being imparted to the anti-cathode.

THE COUNTY OF LONDON AND BRUSH COMPANY'S TRUNK MAINS BILL.

The Attitude of the Vestries.

At the instance of the Battersea Vestry a conference of representatives of the Vestries affected by the South-West London Bill promoted by the County of London and Brush Provincial Electric Lighting Company was held at the Municipal Buildings, Battersea, on the 16th inst., when delegates from Bermondsey, Lambeth, and other parishes were present. The resolutions passed by the conference are summarised in the following extracts from a letter addressed to all the local authorities throughout London by Mr. W. Marcus Wilkins, hon. secretary to the conference. The letter states that the writer was unanimously instructed to request the several authorities affected by the Bill to present a petition against it, if they have not already done so, and if possible to appear by counsel. The Bill was read a first time in the House of Commons on the 14th inst., and the standing orders require petitions to be presented in 10 clear days after the first reading. The hon. secretary states that he was further instructed by the conference to ask the authorities to request their local members of Parliament to oppose the Bill, and to urge their members on the London County Council to support the views of the conference. The letter concludes by promising the dispatch of a printed copy of the resolutions in the course of a few days. When this letter was read at a meeting of the Islington Vestry on Friday, it was resolved, on the motion of Mr. Mills, to adopt the suggestions made by the Battersea Conference. On Monday evening, at a meeting of the Bermondsey Vestry, Mr. Cox, one of the delegates, said that it seemed to be the view of the conference that each individual Vestry should employ counsel. He and his colleagues from Bermondsey objected, however, to that course being adopted, on the ground that it would be absurd for 30 or 40 counsel to appear, they contending that it would be preferable to pool the question, and engage one legal gentleman, and divide the expenses. The Bermondsey delegates also advocated that all members of Parliament should be asked to oppose the Bill on second reading, so as to get it thrown out, and then there would be no necessity to employ counsel. The speaker understood that the Vestry would only present a petition against the Bill, and this was agreed to, as stated in another column.

THE APPLICATION OF ELECTRIC POWER TO PUMPING.

Mr H. S. Bunnell provides several illustrations of pumps driven electrically, to the *Engineering Magazine* in connection with an article on the subject. Pumping, especially in mines, is so often performed at a long distance from the source of energy that electricity appears a particularly desirable agent. Steam is bad, because in the first place it provides more water to be pumped by its own condensation; and secondly, it becomes so very wet in a long pipe that it is little better than hot water. Water power is open to the objection, especially in a deep mine, that it must be at a great pressure above that proper to the depth of the pump below surface, and is thus undesirable, though occasionally valuable. Compressed air is undoubtedly the most useful and desirable of the old agents, for it promotes ventilation, cools the mine, and is fairly efficient as a long distance agent. Electricity is not only this, but has the further advantage that it can be converted and reconverted for less loss than air can be compressed and recompressed. Electricity can also be more easily conveyed than air. Its advantages, moreover, become more apparent with increase of distance. In a sinking job the ease and rapidity of jointing on fresh lengths of wire conductor are very marked as compared with the adding of more pipes as the sinking proceeds. True, an air pipe can be lengthened to some extent by a telescope joint, but not to the same extent as a wire may be coiled up and allowed to extend many yards without piecing in further lengths as the sinking proceeds.

At De Kalb in Illinois, and at Austin, Texas, and other places, the whole of the public water supply is pumped electrically, and pumps for house service as small as 50 gallons per hour are now built by some American makers.

Centrifugal pumps driven by motors are included, though unfortunately without description as to size, the body of the centrifugal pump being, however, fully as large as the outside of the 60-H.P. 4-pole, 550-volt meter. Without doubting the advantage of such a system, we think that such articles ought to provide further information than a mere photographic representation can convey, such as the speed, efficiency, both mechanical, electrical, and combined, at different rates of discharge due either to speed variation or sluice gate opening.

Mr. Pierce, of Johannesburg, gives preference for mine work on the Rand to three-throw crank pumps driven by single reduction motors with cut gears, and either of vertical or horizontal type up to 300 feet, beyond which head the horizontal type is thought to be more suited. He also appears inclined to advise Riedler mechanically operated valves, except for low lifts, though ordinary valves are fully as economical.

As regards the electrical system he advocates a low voltage not exceeding 250 at the motors with polyphase transmission at 1,500 to 2,500, and reconversion as near as possible to the motors, the saving of copper should more than pay for the transformers. As an illustration he assumes 4,000 feet between station and motors, and 100 kw. to be delivered. Three-phase currents at 250 volts and no transformation, and 10 per cent. line loss, will require 38,400 lbs. copper costing, at 1s., £1,720; with 500 volts, which is too high, the copper will be 9,600 lbs., and the cost £480. Now, with 2,500 volts, and still the same loss, including 5 per cent. for the transformers, the copper will be 577 lbs., at a cost of £28 17s., and the transformer at £3 15s. per kw. will cost £375, so that the whole cost will be £403 17s. The 2,500-volt line will also cost less to put up and will admit as much lower than 250 volts at the motors as may be desirable under the circumstances. An air-worked pump is advised for sinking, but pump makers are asked to devise a convenient sinking pump electrically driven.

The Knowles sinking pump, illustrated in the article of Mr. Bunnell's, seems to be just such a pump as is asked for.

The total investment below the shaft collar for a plant to pump 200,000 gallons in 24 hours may be estimated as 30s. to 40s. per 1,000 gallons per 24 hours per 100 feet of lift exclusive of stations, which will cost 15s. to 20s. extra for each station cut, the stations being the relay points.

As regards power this is represented by ·38 kw.-hours per 1,000 gallons per 100 feet per hour. With a total efficiency from shaft mouth to water column of 70 per cent., which Mr. Pierce says is a figure that can easily be reached, the power to pump each 1,000 gallons 100 feet will be ·543 kw.-hours. At 2d. per unit the cost will thus be 1·086d. Maintenance should be under 2 per cent., or 0·015d. per 1,000 gallons if the pumps are, on the average, worked to two-thirds full capacity. One man with one native helper to each station can look after 250 kw. for 12 hours if not more than three stations exist, or 400 kw. for eight hours.

As 250 kw. will pump the equivalent of 11 million gallons against the standard head of 100 feet in 24 hours, the wages of two whites and four natives will come out at not quite ·083d. per 1,000.

Ten per cent. depreciation and 10 per cent. interest amount to ·150d. Hence is found the total cost of 1·334d. per 1,000 gallons pumped 100 feet or the equivalent. Probably an all-round practical figure will be found at 1½d. or 2d., the figures of Mr. Pierce being admittedly favourable.

CIRCULATION IN STEAM BOILERS.

It is suggested in the *Engineer*, that given free escape of steam from the heating surfaces, there is no need for circulation in a steam boiler, for one pint of water is as good as another. This is so. Moreover, the use of high pressures now, it is claimed, very greatly reduces the violence of ebullition in a boiler. At all pressures a steam boiler produces in a given time a definite *weight* of steam. Thus, at 30 lbs. gauge pressure—the pressure of 30 years ago, and at 165 lbs. gauge pressure of to-day, the *volume* of steam produced in the two cases will be as 4 to 1. The bubbles of steam will be either less numerous or smaller in size. In Lancashire boilers, so long as the water in the boiler bottom is once as hot as the remainder of the boiler, it will probably remain so, and it is very unlikely that any rapid circulation of the water is necessary. There is always such a large area of escape for steam. Thus a Lancashire boiler will evaporate, say, 100 lbs. of water per minute from two furnace tubes measuring in plan, say, 30 feet by 3 feet each, or a total of 180 square feet. Each square foot throws up an average of some ·55 lbs. of steam per minute. This corresponds with about 15 cubic inches of water, or is equivalent, approximately, to the removal from each square foot of the semi-circular surface of a sheet of water less than $\frac{1}{12}$th of an inch thick. Say that the furnace parts do all the actual evaporation, and at most some ¼-inch in thickness will be evaporated per minute from the first 10 feet of length of furnace tubes. The specific volume of the steam at the above absolute pressure for 180 lbs. is 155, so that from each unit of area the escape of steam only amounts to a column about 40 inches long per minute or, say, 5 feet in horizontal projection. In other words, steam flows at the rate of 1 inch per second upward from all over the surface if our figures are correct. As to the claim made that circulation prevents the formation of scale this is ridiculed and very properly so. Any one who knows the inside of a boiler knows the fault referred to by the *Engineer*, namely, the choking of the feed pipe. Every drop of water which is evaporated has obviously to flow through the steam pipe in which circulation may be almost described as torrential. Yet feed pipe extensions inside a boiler are notoriously liable to fur up, and this is not due to the deposit of scale from the water but from the well known adhesive effect of nascent molecules of salts as they separate out of solution and crystallise upon the first solid with which they make contact.

As regards water-tube boilers, circulation, usually claimed for them

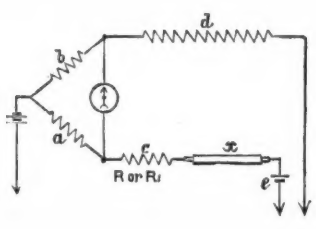
as a virtue, is rather a necessity than a virtue. The water must leave the tubes or it will all be evaporated. In the water-tube boiler the volume of steam formed in the length of a tube is probably so great as to drive the water out at both ends of the tube and leave the tube for a moment dry. Such boilers must have rapid circulation, because otherwise they would become dry and cease to produce steam. In shell boilers the plates of the furnace cannot become dry because gravity acts too directly to feed fresh water up to the plate surfaces.

The unsatisfactory quality of steam from high vertical boilers is due to the small area of water surface and the consequent great length of rising columns of steam and small area of surface of water through which they have to break, hence priming. Large shell boilers owe their capacity of dry steam making to their large water surface and large cross section of steam space, which prevents rapid flow of steam and gives time and opportunity for the deposit of moisture. In shell boilers there is, of course, very little steam produced below the horizontal diameter of the furnace tubes. The water below this level receives heat from nowhere in marine boilers, and only from the bottom flue in Lancashire boilers. It was, indeed, with a view to the better heating of this dead water that the seatings of these boilers were changed from their original system to the present one in which the bottom flue is traversed by the gases before the side flues and while the gases are hot. It is to the large amount of dead water in the bottom of shell boilers that these owe their steadiness under variable load, but the water is slow to heat up and causes slow starting. Of course it should be positively circulated during the process of getting up steam so as to maintain the boiler at a uniform temperature all over. If this is done the getting up of steam may safely be much more rapid. Seeing that to circulate the water in this way it is only necessary to move it, and that there is no difference of level to overcome, a small centrifugal pump would be very easily applied to perform the transference exactly as such pumps are now applied by Messrs. Mather & Platt in some of their boiling kiers.

MODIFIED BRIDGE METHOD OF MEASURING RESISTANCES CONTAINING EARTH CURRENTS.

UNDER the above heading Mr. R. R. Black, electrician to the Eastern Extension Telegraph Company, contributes to the *Electrician*, of January 13th, an interesting article in which he explains a modification of the bridge null method for measuring by reversals the conductor resistance of a cable in which earth currents exist. The important feature in the test consists in the fact that inasmuch as the internal resistance of the battery does not enter into the formula, the somewhat lengthy correction ordinarily applied to bridge tests by reversals, or to Mance's test, is in this method unnecessary, and the evaluation of x is in consequence facilitated.

Mr. Black points out that balancing to instrument zero in the bridge methods is more sensitive than the *false zero* method, unless the latter can be taken without a shunt on the galvanometer, and we may add that the more important difficulty of the *false zero* test is that when testing a long cable it is uncertain what should be taken as the true false zero, owing to the initial discharge after taking off the testing current and putting to earth. Moreover, when a ship is paying out a cable, of which a long length still remains coiled in the tanks, this difficulty, owing to retardation, becomes greatly increased. Again, under these conditions, the induced currents due to the ship's movements, though troublesome, do not prevent a tolerably exact



measurement by a *null* method, as the adjustment is made till equal undulations are obtained on either side of the instrument zero; whereas the *false zero* will also be largely affected by the direction of the induced currents, so that measuring by this last-named method becomes impracticable.

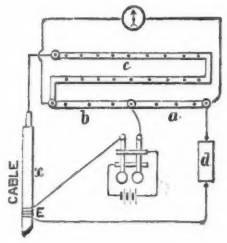
The true determination of the C R of a cable in which a foreign E.M.F. exists is by no means a simple process, and any attempts to render it more so, either in the method or in calculating results, will be welcomed by cable electricians.

We therefore reproduce for the benefit of our readers Mr. Black's modification of the ordinary bridge test, and offer certain remarks which suggest themselves in connection with its practical application.

The proportional parts, a and b, and also branch d, have fixed resistances suitable to the resistance to be measured; in addition to which an adjustable resistance, c, is inserted between the bridge and the line, x, which latter is traversed by an earth current. Branch c is first adjusted until a balance to instrument zero is obtained with a resistance of (say) R units; after which the testing current is reversed and a balance again established by altering R to R_1. These two operations are repeated till a series of values are obtained from which the mean of several values for R and R_1 is taken for applying the formula $x = d\frac{a}{b} - \frac{R + R_1}{2}$. If, as is usually the case, the proportional parts a and b are equal, then $x = d - \frac{R + R_1}{2}$.

When the earth current in the line coincides in direction with the testing current, its effect is equivalent to a diminution in the conductor resistance, and the adjustable resistance must be increased to, say, R units in order to equal the fixed resistance d. On the other hand, when the testing current is reversed the cable current is opposed to it, the effect being equivalent to an increase in the conductor, and R has to be reduced till R_1 and the line x together again balance the fixed resistance d.

It is clear that since the opposition of the *testing* and *earth* currents is equivalent in effect to an increase in the line



resistance, the fixed resistance d must be greater than x by an amount which will compensate this effect. Mr. Black says that d is, as a rule, made about 25 per cent. higher than the estimated value of $x\frac{b}{a}$ (if unequal proportional parts are used), or of x when a and b are equal; but in one of his examples he found that, owing to the strong earth current present, d had to be 50 per cent. higher than the actual resistance of x.

In the following table are some comparative results which we have obtained from Mr. Black's test, and also by *false zero*—ordinary bridge reversals (corrected by Kempe's formula)—and Mance's method. For these tests the line was obtained from ordinary resistance coils, and the foreign E.M.F., representing the earth current, from Daniell gravity cells shunted with various resistances, which afforded an almost constant value. The measured internal resistance of this shunted *line battery* (see col. 3) is therefore added in col. 6 to that of the line, and it is with this column that the results in cols. 13, 14, 17, and 20 must be compared.

It will be seen that all the four methods give very exact results under all the several conditions of line resistance and earth current, and, in fact, any slight disparity must be attributed to an error in observation.

In point of accuracy then, Mr. Black's method gives as good results as any other; it shares with the ordinary bridge test and Mance's test the advantage of being a *null* method, and therefore very sensitive, and, in comparison with these tests, working out results is certainly more expeditiously done. In this last respect, however, the advantage must not be too highly appraised because the internal resistance of the testing battery required in Kempe's or Schwendler's corrections for the *ordinary* bridge reversals, and also for

Example.	Cable current E.M.F.	$\frac{b}{b+s}$	Line resistance.		Total resistance in circuit.	Testing battery. Leclanché cells.	Fixed resistance, d.		Black's test.			Balancing to false zero.	† Ordinary bridge test.			Mance's test.		Proportional parts.
													Reversals					
			Marked	Measured		No.	Marked	Measured	Z	C	Calc. value	x	Z	C	x	$B_1 - B_2$	x	Ratio.
No.	Volts.	ω	ω	ω	ω		ω	ω	B	B_1	x							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(20)	
I.	0·64	1·8	400	402·4	404·2	10	500	498·9	158	32	403·9	404	335	460	403·9	*382	404·3	1000/1000
II.	1·49	4·1	4,000	4,006	4,010·1	20	5,000	4,990	1,285	673	4,011	4,012	3,765	4,286	4,012·2	†3,765	4,011·8	,,
III.	,,	,,	8,000	8,004	8,008·1	36	10,000	9,981	2,545	1,400	8,008·5	8,010	7,505	8,544·5	8,010	†7,754	8,006·8	10000/10000
IV.	2·5	6·9	4,000	4,006	4,012·9	20	5,000	4,990	1,523·5	428·7	4,013·9	4,018	3,791	4,525	4,015·3	†3,591	4,013·1	1000/1000
V.	,,	,,	7,000	7,005	7,011·9	36	10,000	9,981	2,968	35	7,013	7,013	6,189	7,924	7,012·4	†6,620·2	7,009·9	10000/10000
VI.	,,	,,	400	402·4	409·3	10	740	738·2	655·4	3·5	408·7	410	183·6	739·5	409·5	*323·7	409·8	1000/1000
VII.	,,	,,	,,	,,	,,	20	570	568·7	313	4·5	410	...	...	...	...	...	...	,,
VIII.	1·49	4·1	,,	,,	406·5	10	600	598·6	374·5	10·5	406·1	...	263·2	584·9	406·2	...	...	,,
IX.	2·5	6·9	,,	,,	409·3	20	583	578·7	329	10·2	409·1	...	280·1	566·4	409·5	...	...	,,
X.	4·2	11·8	4,000	4,006	4,017·8	10	6,620	6,608·5	5,169	8·6	4,019·7	...	2,740	6,605	4,017	...	...	,,
XI.	8·9	25·4	,,	,,	4,031·4	20	6,680	6,668·5	5,255	7	4,037·5	...	2,744	6,662	4,034·8	...	...	,,
XII.	,,	,,	,,	,,	,,	36	5,184	5,174·5	2,260·5	13	4,037·7	...	3,260	5,166	4,041	...	...	,,
XIII.	,,	,,	8,000	8,004	8,029·5	,,	10,040	10,021	3,973	5	8,032·1	...	6,655	10,023	8,037·8	...	...	,,
XIV.	,,	,,	,,	,,	,,	,,	12,005	11,981·5	7,884	17	8,031	...	...	...	...	...	...	10000/10000

* Ratios, 100 to 100 and 1,000 to 1,000.

† Corrected by Kempe's formula.

‡ Ratios, 1,000 to 1,000 and 10,000 to 10,000.

Mance's method, is generally known (or has only to be determined once for all), so that the evaluation of x from these formulæ is not after all a very lengthy process, and any disadvantage on this account must be set off against the fact that these tests do not require the additional resistance, d, which would not always be available. To meet the requirements of any cable, d would have to take the form of a resistance box having various high resistances, and this would be an important addition to a testing set.

Examples 6 to 10 show that when testing a cable conductor traversed by moderately strong cable currents, d (see col. 10) would have to be not only 25 per cent. greater than the line resistance (col. 6), but sometimes more than 50 per cent. greater, even when the resistance unplugged in c to balance for B_1 is reduced almost to its smallest value.

It will be apparent from a comparison of cols. 6, 7, and 10 in the table of experimental tests, that the suitable value to be unplugged in d depends on the strength both of the *earth* current and the *testing* current, and consequently on the value of the proportional parts, a and b, since these modify the testing current considerably. Thus for a given *testing* current d must be larger for a strong than for a weak earth current; and for a given *earth* current d must be larger for a weak than for a strong testing current, and also for 10 000 to 10,000 than for 1,000 to 1,000 proportional parts. Now, since the value of the earth current is unknown (and sometimes also the line resistance is only known approximately), it will sometimes be found, after starting the test, that the adjustment limits of c can not bring about a balance with both z and c testing currents, and d would in that event have to be altered, so that more time may easily be lost thereby than is saved by a simplification of the test formula. The simplest way to arrive speedily at a suitable value for d would appear to be the following procedure:—First unplug (say) 200 units in c so as to admit of this resistance being further reduced during the test if required. Next observe the direction of the earth current and, if positive, test first with the positive pole of the battery (and if negative with the negative testing current) to the centre of the bridge, and adjust d till an approximate balance to instrument zero be obtained, after which d need not be touched. The final finer adjustment of the balance can then be made by altering c.

On reversing the testing battery the *earth* and *testing* currents will coincide in direction and the apparent resistance of the line will be reduced, so that the resistance in c must now be increased to re-balance, which the limits of this adjustable resistance (in the direction of an increase) will generally admit of unless the cable be very long, in which case the adjustable resistance, c, may be augmented, before commencing to test, by inserting (say) 10,000$^{\omega}$—in order to allow ample margin—out of the high resistance box used for insulation tests. The series of balances with reversals may then be proceeded with by means of c while d remains unchanged.

Commenting on the above test in the *Electrician*, of February 10th, Mr. Walter J. Murphy says that, "it is not always safe to assume that the polarisations and consequently the effective E.M.Fs. of the battery and earths will be the same when the flow of the testing current is in one direction as when in the other, even if the time intervals between the reversals be made practically equal; nor that they will even be so for currents of similar sign after a reversal."

While it is no doubt true that accuracy would on this account result from "accepting only balances when the testing currents are observed to settle down to some given constant value," we fear that the necessity of a mil-ammeter, as well as the fixed resistance, d, and the time lost while waiting for the testing current to become constant would make a C R test in this way rather too elaborate and lengthy an operation, on a repairing steamer at any rate, because not only may the current due to earth polarisation, referred to by Mr. Murphy, vary, but, if the cable be long, so also may the *earth currents* to a much greater extent.

When this is the case, as great accuracy would probably result from a series of measurements in quick succession by this, or by the ordinary bridge test with reversals, as by waiting for the testing current "to settle down to some given constant value."

Mr. Murphy goes on to say that "reversal methods should be used sparingly and with caution. They are only reli-

able when the battery, line, and earths are practically perfect, and they should be employed as a rule only as a check method on perfect cables."

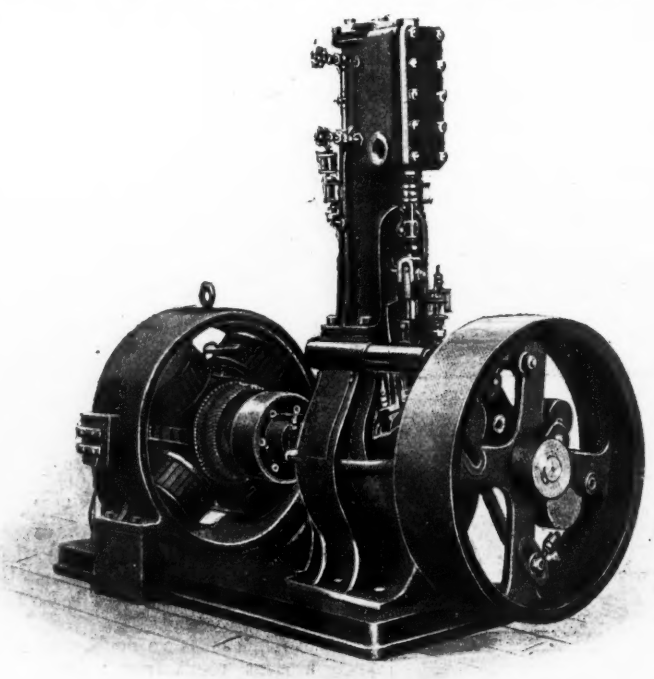
In Mr. Black's description of his test there does not appear any suggestion that he contemplates using it for measuring the C R of a *faulty cable*, for which, of course, it would not be so correct as some other tests, because the negative current would tend to open, and the positive current to seal up, a fault; and for good cables it is as reliable as any other method. If not, what would be the utility of employing it as a *check method* on another test?

Mr. Murphy's "further and most important objection" to testing with reversals is "that observers are prevented from obtaining the training and practice necessary for the successful application of E C zero tests."

It certainly is not always easy "to recognise the correct moment at which the E C zero should be taken," and this would appear to be the best reason why—to the uninitiated at least—Mr. Black's, or any other, test to instrument zero should be preferred in cases where it is suitable. Moreover, as already pointed out in the case of a cable partly coiled in the ship's tanks, testing by *false zero* zero is impracticable, owing to induced currents arising from the ship's motion.

STURTEVANT VERTICAL ENGINE AND FOUR-POLE GENERATOR.*

We illustrate herewith the automatic single upright engines and direct connected four-pole generator now being built by the B. F. Sturtevant Company, of Boston. The types of single engine here shown have balanced piston valves, thorough oiling devices and regulators designed for close control of speed; and they are built for high and low steam pressures.



The armature of the Sturtevant multipolar machine is of the barrel-wound type. The cast-iron flange, bolted to the armature spider at each end of the core, forms a support as well as a cylindrical receptacle for the projecting ends of the coils. The flange extension also protects the windings from any oil that may be thrown from the bearings. The surface of the interior of the armature is perfectly smooth, offering no opportunity for the collection of oil or dust. Ventilation is effected by the use of specially constructed vanes, forming air ducts between the laminæ of the core. These convert the armature into a blower and create a strong draught through the windings.

These generators are at present built in nine sizes, from 8 kw. at 1,200 revolutions per minute and a weight of 750 lbs., up to 100 kw. at 600 revolutions and a weight of 8,000 lbs. The generators can, of course, be built for higher or lower speeds and for belt connection, and can be compound wound for 125, 250 or 500 volts.

* New York *Electrical Engineer*.

SYNCHRONISERS.

The process of paralleling alternators requires special precautions to avoid unnecessarily severe strains upon the machines.

Two conditions must be fulfilled for parallel running. They are:—

1. The two machines must have the same voltage and frequency; and

2. At the moment of switching them into parallel the instantaneous voltages of the two machines should be equal and of the same sign. The voltages of the machines can easily be made approximately equal by varying the excitation and reading the voltmeters between the machine terminals. To get the frequencies the same and the potential differences in the same phase is a more difficult matter.

It is easy to see that if a_1 a_2 and b_1 b_2 are corresponding terminals of the machines there will only be zero potential difference between a_1 and b_1 or a_2 and b_2 when the E M.Fs. of the two machines are identical in frequency and phase, even though the voltmeters between the terminals of the machines read alike. The consequence is that if the machines are switched in parallel without being accurately synchronised, there will be a sudden rush of abnormal current through these armatures which cause a more or less severe strain on alternators and engines alike. A simple method of detecting when the machines are or are not in synchronism is to connect a_1 and a_2 and b_1 and b_2 by means of incandescent lamps. This device forms a good indicator as to whether there is or is not a difference of phase between the E.M.Fs. of the machines, but it is insufficient in that it gives no indication whatever which of the two machines is running the quicker.

This requisite is supplied for three-phase alternators by the Siemens and Halske synchroniser which we proceed to describe.

The accompanying figure represents the method connecting a Siemens and Halske synchroniser for the paralleling of three tri-phase alternators.

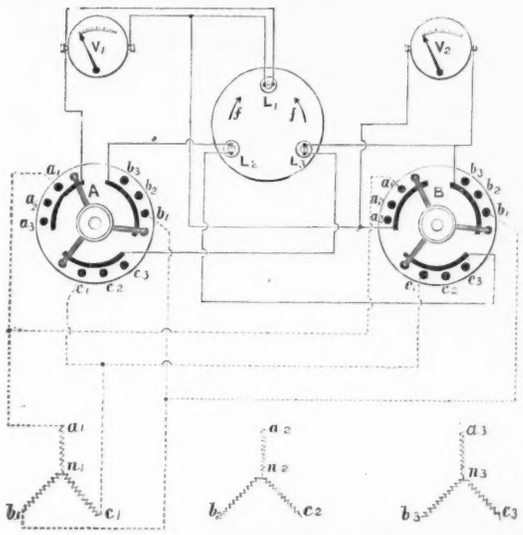
The phases a_1 b_1, b_1 c_1, c_1 a_1 of the first alternator are connected to the terminals, a_1 b_1 c_1, of two triple-pole switches, A B, which are themselves coupled in parallel. The phases of the other two alternators are respectively connected to the terminals, a_2 b_2 c_2, a_3 b_3 c_3, of two other switches.

The lamp device is still used, but now there are three terminals to each machine and three lamps are used as indicators between corresponding terminals of the machines already connected to the bus bars and the incoming machine.

The extinctions of the three lamps do not occur simultaneously but successively, and if the lamps are mounted in a triangle as shown in the diagram at L_1 L_2 L_3, the order of ex-

tinction will travel round the triangle in a clockwise or counter-clockwise direction according as the incoming machine is slower or quicker than those already on the bus bars. The direction of the order of extinction of the lamps tells at once whether the incoming machine is running too quickly or too slowly.

Suppose it is desired to parallel machine II. with machine I. which is already connected to the bus bars. The first thing to do is to see that the voltages of the two machines are alike by means of the voltmeters. Having done this the switch, B, is left on the terminals, a_2 b_2 c_2, and the switch, A, is placed on the terminals, a_1 b_1 c_1, of the alternator I. The



ALTERNATOR I. ALTERNATOR II. ALTERNATOR III.

direction, f or f_1, of the order of the extinctions of the lamps is then noted; if the order is f the incoming alternator has to be accelerated, and if the order is f_1 it has to be retarded. The main switches are closed at the instant that the lamp, L_1, is dark, when the rate of the extinctions shows that the speed of the machines are almost exactly the same. To increase the sensibility a voltmeter, V_1, is between the terminals of the lamp, L_1, and should register zero voltage at the instant of switching on.

A device which would serve for single-phase alternating currents the same purpose which the Siemens & Halske synchronisers serves for tri-phase currents is badly wanted. It would render the work of synchronising a much simpler process.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

2,610. "Improvements in the manufacture of insulating material for electric cables." G. E. HEYL-DIA. Dated February 6th. (*Complete.*)

2,627. "Electrical central alarm." J. W. H. WENDT and K. L. KRAUSSE. Dated February 6th. (*Complete.*)

2,654. "Improvements in electric switches." E. L. JOSEPH. Dated February 6th. (*Complete.*)

2,656. "Improvements in electrolysis and in apparatus therefor." W. P. THOMPSON. (Dubose and Bertin, ——.) Dated February 6th.

2,657. "Improvements in the manufacture of aluminium calcium carbide and other substances by the electric furnace and in apparatus therefor." W. P. THOMPSON. Dated February 6th.

2,660. "Improvements in electrical influence machines." C. S. LEMSTRÖM. Dated February 6th.

2,665. "Automatic electrical apparatus for indicating leaks in ships." W. W. ZWORIKIN and S. DE BLUMENTHAL. Dated February 6th.

2,726. "Improvements in electrical measuring instruments." J. W. FLOWER and T. E. GAMBRELL. Dated February 7th. (*Complete.*)

2,741. "Improvements in secondary battery plates, grids, and the like." J. S. GRANVILLE. Dated February 7th.

2,742. "Improvements relating to electrical floats for theatrical purposes."

2,778. "Improvements in jointing or connecting electric conductors." A. ELLIS. Dated February 7th.

2,794. "Improvements in electric traction." W. B. DAY. Dated February 8th.

2,811. "Overhead electric trolley automatic cut-out." E. EDWARDS. Dated February 8th.

2,815. "Automatic machine for regulating the speed of steam engines, and for controlling the voltage and amperes of electric circuits." R. WILBY. Dated February 8th.

2,825. "Signals to indicate the approaching exhaustion of the carbons in electric arc lamps." E. A. CLAREMONT and F. H. ROYCE. Dated February 8th. (*Complete.*)

2,845. "Improvements in secondary batteries and in means for combining electric lamps therewith." W. A CROWDUS. Dated February 8th.

2,849. "Improvements in electro-magnetic apparatus for separating ores." E. KRAISER. Dated February 8th. (*Complete.*)

2,852. "An improvement in holders for electric safety fuses." P. F. W. SIMON and H. H. BERRY. Dated February 8th.

2,906. "Improvements relating to switchboards." C. H. COX. Dated February 9th.

2,916. "Improvements in electric switches." V. G. LIBONI, O. MOON and J. A. O'LOUGHLIN. Dated February 9th.

2,929. "Improvements in or relating to insulating blocks connected with holders for incandescent electric lamps." S. H. SMITH. Dated February 9th.

2,932. "Improvements in or connected with electric batteries." A. D. SETON and J. L. DOBELL. Dated February 9th.

2,934. "Improvements in or relating to induction coils." M. E. FULD Dated February 9th. (*Complete.*)

2,956. "An improvement in apparatus for controlling electric motors." SIEMENS BROS. & CO., LIMITED, and J. G. WILSON. Dated February 9th. (*Complete.*)

2,971. "Improvements in arc lamps." H. J. BAGLEY. Dated February 10th. (*Complete.*)

2,994. "Improvements in and relating to electric arc lamps." P. RZEPKA. Dated February 10th. (*Complete.*)

3,005. "Improvements in and connected with electrical switches." W. H. LANE. Dated February 10th.

3,007. "Improvements in apparatus for the detection of electrical leakage in surroundings in buildings or in the open air." E. S. D'ODIARDI and W. J. BISHOP. Dated February 10th.

3,020. "Improvements in electrical connections for railway trains." D. CUNNINGHAM. Dated February 10th

3,028. "Improvements in combined automatic magnetic circuit breakers and resistance controlling switch." H. H. LAKE. (H. B. Cutter, United States.) Dated February 10th.

3,032. "Improvements in printed telegraph machines." THE TELESCRIPTOR SYNDICATE, LIMITED, and A. L. SHEPARD. Dated February 10th.

3,047. "Improvements in continuous current dynamo-electric machines." A. O. BERRY. Dated February 10th.

3,051. "Electric illuminating apparatus." S. BAUER. Dated February 10th. (*Complete.*)

3,087. "An improved electric fitting for ships' lanterns." W. M. HADDOW and J. S. HUTCHISON. Dated February 11th.

3,090. "Improvements in electrical tap switch-holders." T. MARSHALL. Dated February 11th.

3,130. "Improvements in electric lamps." A. C. BROWN. Dated February 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. (*in stamps*).

1897.

129. "Improvements in dynamo-electric machines." SIEMENS, BROS., & Co., LTD., and E. F. H. H. LAUCKERT. Dated January 2nd, 1897. A disc armature is built up of two non-magnetic discs, mounted on the shaft, and having oppositely-sloped ratchet teeth on their peripheries, between which and two internally toothed non-magnetic rings are held bundles of iron strips, bearing perpendicularly against the slopes of the teeth. The coils are secured against the discs and rings by clips, and the spaces within the bobbins may be filled in with wood. 1 claim.

272. "Improvements in secondary battery supports or grids." J. J. ROONEY. Dated January 5th, 1897. Frames or grids are made up of strips of wool felt laid crosswise on each other so as to leave spaces for the active material. The grid is built up of a number of vertically arranged hollow perforated casings, between which the

strips are laid and fastened together by sealing wax melted by hot air introduced into the casings. Asbestos may be used in making the grids, and the casings may be replaced by pins arranged in rectangles. 3 claims.

1,087. "Improvements in pipes and conduits used for electric cable mains and in jointing the same." N. SIMMONS. Dated January 15th, 1897. Conduits for electric mains are formed of pipes divided longitudinally. Each length is recessed or provided with recess and projecting edge longitudinally along the meeting edges. The recesses receive a packing of any desired shape but preferably of V section. The two parts are held together by bolts passing through lugs or by separate bracing rings provided with clamping lugs and bolts. The meeting edges may form internal and external flanges. Lengths may be formed with branches or inspection openings. The lengths fit together by spigot joints, a circular packing ring being employed. 4 claims.

1,435. "Improvements in or relating to electric railways on the sectional conductor system." J. F. MCLAUGHLIN. Dated January 19th, 1897. Relates to sectional conductor system with groups of conductors connected to an electro-magnetic switch. The sectional conductors are connected to contacts, over which an arm connected to the main supply is advanced step by step by a ratchet mechanism worked by the armature of an electro-magnet. The latter is excited by a current from the vehicle as it passes over the plugs in the road. The connections for a single line worked in both directions, two switches are used, and one or the other is operated according as a shoe is lowered from the vehicle to rub over one or other of the two series of plugs. A modified form of switch has two magnets, which are excited according to the direction in which the vehicle travels, and other slight modifications of the circuits, &c., are described. 12 claims.

1,734. "A system of electrical signalling or communication between the occupant or occupants of a cab, carriage, or other road vehicle propelled by horse or other power, and the driver or drivers thereof and apparatus therefor." W. P. MAYCOCK. Dated January 22nd, 1897. Relates to means for communicating between the passengers and drivers of road vehicles. Two double contact keys and a single contact key are mounted in a suitable case, &c., inside the vehicle, and are connected by leads to two bells of different tones, or to a bell and buzzer which are mounted in a casing placed outside the vehicle and conveniently near the driver. The bells are sounded separately by pressing their respective keys and simultaneously by pressing the single contact key, the keys normally touching their upper contacts. The three signals denote respectively "turn to the left," "turn to the right," and "start" or "stop." 3 claims.

1,827. "Improvements in and connected with electric motor-cars." W. E. HEYS. (J. J. Heilmann, France.) Dated January 23rd, 1897. A high-speed petroleum engine drives a dynamo, the current from which traverses a rheostat on its way to the electro-motor, which is suspended upon the rear axle and by springs. The electro-motor is wound in series and drives the balance gear of the "Starley" or other suitable type. The field-magnets of the dynamo may be excited by a separate dynamo, and a steam engine of the type described in specification No. 5,118, A.D. 1894, may be substituted for the petroleum motor. 4 claims.

1,936. "Improvements in electricity distributing boxes." W. H. WILLATT. Dated January 25th, 1997. Distributing boxes are formed with a watertight joint between the cover and the base, and also with an insulating support for the wires. A box is formed with two walls, and in the annular space so formed an India-rubber ring is fitted. The wires are passed in through holes in the walls and ring. The cover is then screwed on, compressing the ring and so making a tight joint with the base and around the wires. The insulator consists of a stud, on which is fitted an insulating sleeve and washers, between which the wires are clamped, another insulating sleeve, a washer, and finally a nut. 3 claims.

2,418. "An improved form of electrode for galvanic or secondary batteries." E. W. BONSON. Dated January 29th, 1897. The electrodes are made up of a number of comb-like plates formed up into a frame as shown. The teeth of the comb consist of lead strips, which may be plain or corrugated. The bars may have teeth projecting on each side of them. 2 claims.

2,582. "Improved means for use in operating successively two or more electrical switches or sets of switches." T. H. PARKER. Dated February 1st, 1897. Relates to means for operating in succession two or more switches, or sets of switches, for controlling motors, &c., by a single movement of a handle. One arrangement consists of two discs mounted on a spindle which is provided with a handle or hand-wheel. A resistance switch and a moving arm, which is carried by the spindle. Levers pivoted and forked at one end to engage with studs carried by the discs. They also have projections which engage with recesses in the discs. The other ends of the levers engage with switches as shown. On turning the hand-wheel, the levers are successively actuated, as indicated in dotted lines, and are locked against return. The levers may control the field magnet circuits and the armature circuits, and by suitably arranging the discs a reversing switch also. Any number of discs may be mounted on the spindle and successively operate switches. 5 claims.

3,363. "Improvements in electric cables." S. Z. DE FERRANTI. Dated February 9th, 1897. Cables of the kind described in specification No. 22,923, A.D. 1892, are built up by leading the circular strands through bevelled die presses in which they are squeezed to the required section. The insulator is then applied by winding machinery to each strand, or by leading through conical dies a strip is folded over the conductor, after which the two parts are rolled together and further layers are wound on so as to be ready for the final armouring. Two forms of covering apparatus are described; in the first, the core is shaped after it leaves a drum, the insulation being applied as a longitudinal strip, and after the two cores are rolled together the outer insulation is put on before it reaches the take-up drum. In the second form, the first insulation is wound on after shaping, and, after rolling the two together, the cable is taken up on a drum so rotated as to twist the two cores together; the further insulation and armouring being afterwards applied. 20 claims.

4,064. "Improvements in electric insulators." R. DELÉRY. Dated February 15th, 1897. Insulators are formed by screwing together in two parts an internally and externally screwed ring, a groove being provided to receive the wire. The insulator is secured by a screw stem. 3 claims.

4,198. "Improvements in and relating to electric motors and dynamo-electric machines." H. H. LAKE. (E. A. Sperry, United States.) Dated February 16th, 1897. Relates to means for controlling electric motors, particularly such as are used for propelling vehicles on streets or other railways, and for converting the motors into generators when stopping the vehicle so as to supply current to a system of electric brakes. In addition to the ordinary field coil the motor is provided with an auxiliary field coil of comparatively high resistance. The brushes and contacts of the controller are so arranged that, when the handle power is thrown to the off position, the armature connections are reversed and the circuit is completed through the auxiliary field coil, which maintains a certain amount of field magetisation as long as the car is running. A shunt is closed across the brake magnets. Further movement of the power handle in the same direction short circuits the auxiliary coil and the connections are established. The regulating resistances are so arranged that a larger number come into action on the brake side than on the power side. An automatic switch in the brake circuit, consisting of a magnet and pivoted armature, closes a shunt round the field-magnet should the current exceed a certain limit. In the case of a motor vehicle the brakes are connected in parallel across two conductors, one of which is grounded; in the case of a "trailer" they are connected in a group, the members of which are connected in parallel with each other, while the group as a whole is in series with the source of supply and includes a regulating resistance. 29 claims.

5,819. "Apparatus for the demonstration of animal magnetic phenomena." H. PULS. Dated March 4th, 1897. Animal magnetism indicating. An indicator which may consist of two feathers fixed on a central bearing cap, so that it can turn horizontally on a supporting point, or may be an oval or other piece of any other material, similarly mounted, is stated to be attracted or repelled by the hand or any object held in the hand. 4 claims.

5,859. "Improvements in electrical switches." C. M. DORMAN and R. A. SMITH. Dated March 5th, 1897. The object is to give a quick break with considerable clearance. The handle and base are preferably made of porcelain. Brackets are secured to the base, and carry the spindle of the handle and also the spindle of the movable contact. This contact is forked or formed like sugar-tongs, and when in the on position completes the circuit between fixed terminals. It operated by the arms of a forked piece attached to the handle by the sunken nut. A quick break is given by a spring wound on a rod fixed to a shaft, pivoted to the contact, and sliding in a second shaft pivoted in the brackets. The terminals consist of angle plates clamped by hollow screws which pass through nuts inserted into recesses formed in the base. The wires are led in through the hollow screws and clamped by binding screws. 4 claims.

6,351. "Improvements in electric incandescent lampholders." H. H. HALL and T. CLARKE. Dated March 11th, 1897. Relates to holders for incandescent lamps. A holder is screwed externally to fit a coupling nut on a flanged nozzle previously attached to a bracket or other support, in order that the holder may be fixed after it has been wired, without twisting the wires. Holes are made in the casing, affording direct access to the binding screws, without taking the holder to pieces. The casing screws into the part of the holder. 3 claims.

18,718. "Improvements in and relating to electric railways and tramways with overhead conductors." S. H. SHORT. Dated August 12th, 1897. Electric railways and tramways on the overhead system. Collectors. The trolley pole is mounted to swing in a vertical plane without lateral swing when in use, and several forms of heads and supports are described for this purpose. The socket which carries the pole vibrates on a vertical axis carried on a swivelling stand, and is held up to the conductor by springs. The swivelling stand is, however, locked, except when the pole is pulled down to the horizontal position for turning it round, so that the vehicle may run in the opposite direction. The joints and suspending pieces are made of slotted pieces closed on to the conductor, so as to leave the wire projecting on the underside. At curves insulated guys support the conductors from a common point above and at the side of the conductors. 21 claims.

18,718A. "Improvements in and relating to electric railways and tramways." S. H. SHORT. Dated August 12th, 1897. Relates to a system of supplying electricity to the vehicle. The vehicle carries two trolleys or shoes which make contact respectively with two systems of contacts. One set of contacts is connected by branch conductors to the conductors connected to the auxiliary generator, which produces a current which is small and not dangerous, while the other contacts are connected by branch conductors to the main conductor connected to the main generator. The shoes connected to the motors, &c., from which the current may pass to the road wheel and return by the rail. Switch levers and electro-magnets are arranged in the conductors respectively. When the shoe connects two or more contacts, the electro-magnets are energised, and the main current is allowed to flow from the levers to the contacts, and thus to the motors. 3 claims.